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S Y S T E M E N G I N E E R I N G

A N D

M A N A G E M E N T

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U 5098

CURRENT SYSTEM ACQUISITION PROBLEMS

COMBINATION OF THE FOLLOWING:

- ACQUISITION PROCESS LENGTHY.
- INCOMPLETE SYSTEM DEFINITION.
- HIGH SYSTEM SUPPORT COSTS.
- VARIOUS ELEMENTS OF SYSTEM NOT COMPATIBLE.
- BASE FOR RATIONAL DECISIONS NOT COMPLETE.
- DESIGN SOLUTIONS NOT COST - EFFECTIVE.
- COST – SCHEDULE – TECHNICAL PARAMETERS NOT INTEGRATED.
- REQUIREMENTS AND INTERFACES NOT CORRELATABLE.

RESULTS: SYSTEMS BEING DEVELOPED ARE (1) NOT MEETING MISSION REQUIREMENTS, AND (2) ARE NOT COST - EFFECTIVE.

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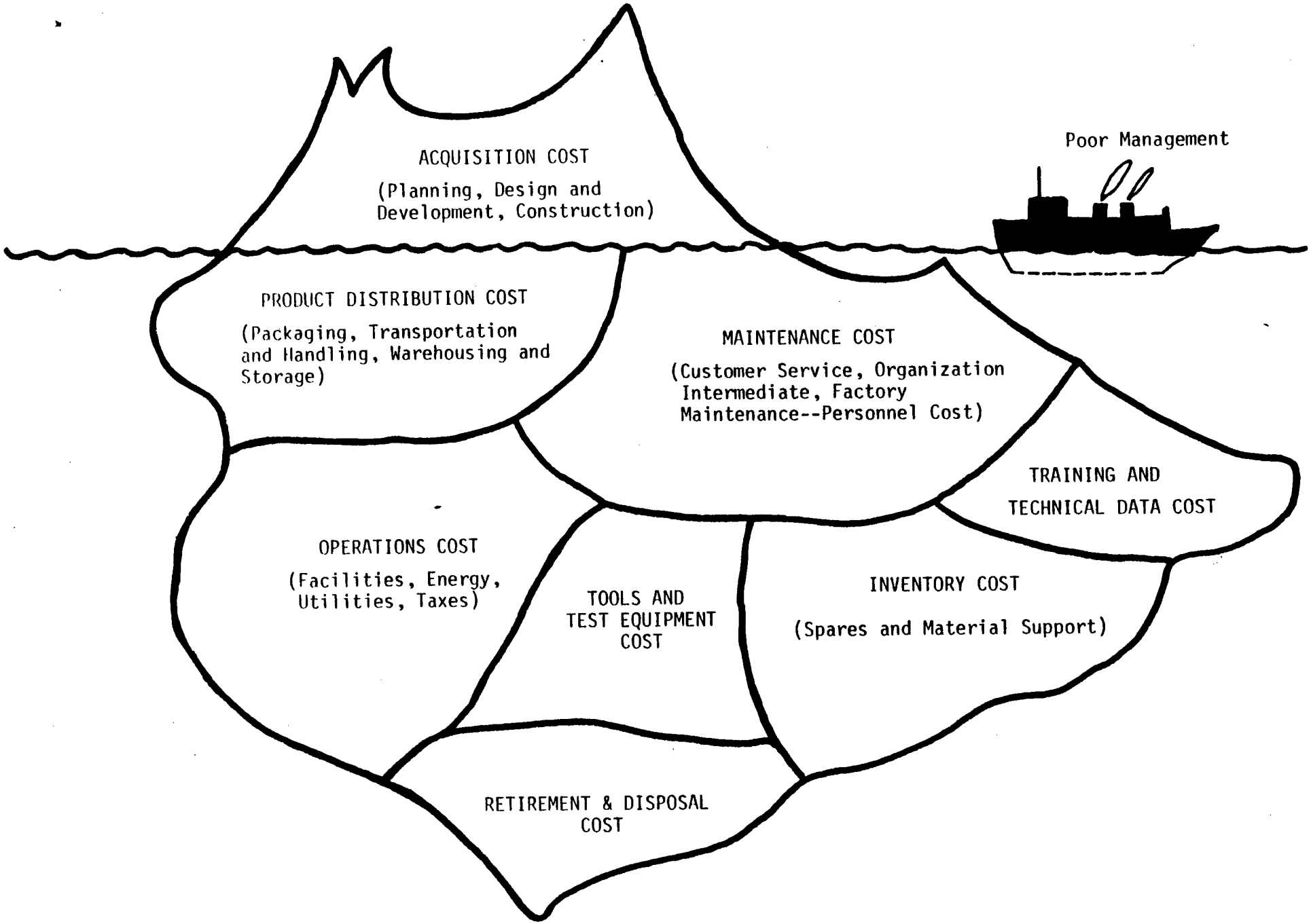
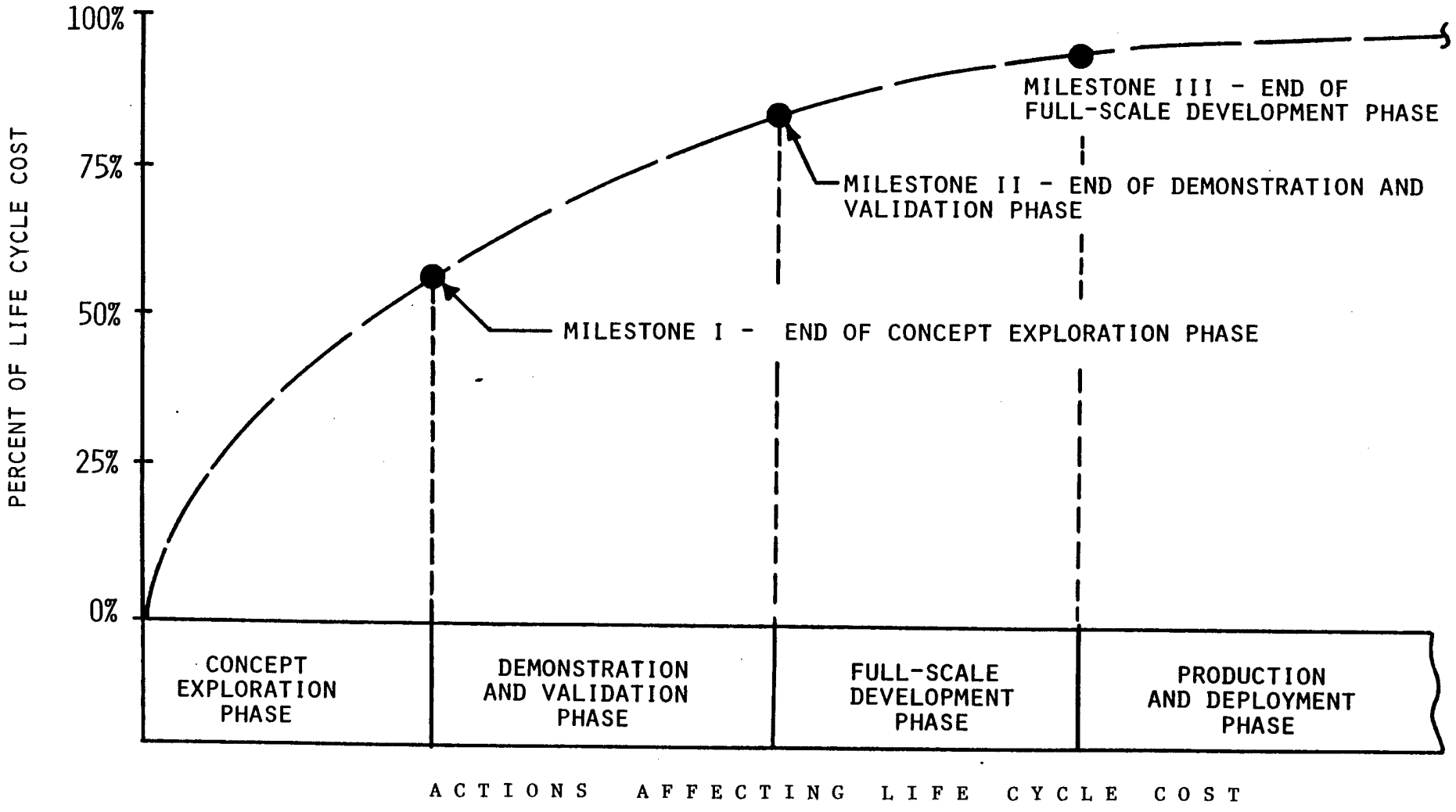


TOTAL COST VISIBILITY

COMMITMENT OF LIFE CYCLE COST



FUTURE REQUIREMENT

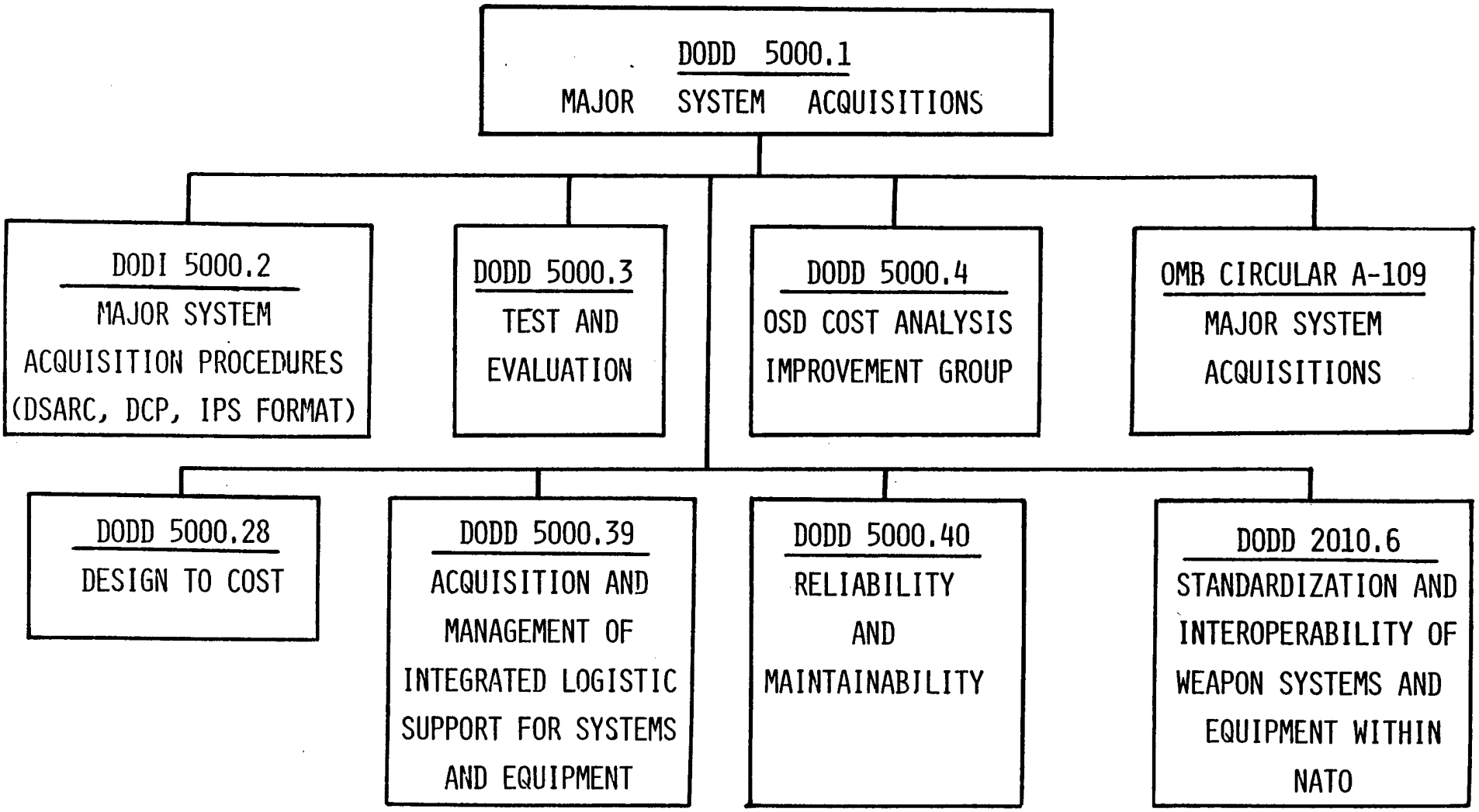
THE

APPLICATION OF A TOTAL

"SYSTEMS APPROACH"

IN THE EARLY PHASES OF A PROGRAM

THE DOD POLICY TREE FOR ACQUISITION MANAGEMENT



S Y S T E M A C Q U I S I T I O N

ACQUISITION MANAGEMENT PRINCIPLES AND OBJECTIVES INCLUDE (DODD 5000.1, "MAJOR SYSTEM ACQUISITIONS," MARCH 29, 1982):

- ACHIEVING EFFECTIVE DESIGN AND PRICE COMPETITION FOR DEFENSE SYSTEMS (TO ENSURE THAT SYSTEMS ARE COST-EFFECTIVE AND RESPONSIVE TO MISSION NEEDS).
- IMPROVING SYSTEM READINESS AND SUSTAINABILITY.
- ACHIEVING STABILITY IN ACQUISITION PROGRAMS (BETTER LONG RANGE PLANNING, IMPROVED BUDGETING, CONSIDERATION OF PREPLANNED PRODUCT IMPROVEMENTS TO REDUCE RISK, ETC.)
- PROMOTING EFFICIENCY IN THE ACQUISITION PROCESS (BY DELEGATING AUTHORITY TO LOWEST EFFECTIVE LEVEL OF ORGANIZATION, AND BY CLEARLY ESTABLISHING RESPONSIBILITY AND ACCOUNTABILITY).
- ACHIEVING A COST-EFFECTIVE BALANCE AMONG ACQUISITION COSTS, OWNERSHIP COSTS, AND SYSTEM EFFECTIVENESS REQUIREMENTS.
- COOPERATING WITH U.S. ALLIES IN THE ACQUISITION OF DEFENSE SYSTEMS (STANDARDIZATION AND INTEROPERABILITY).
- ACHIEVING A STRONG INDUSTRIAL BASE (TO PROVIDE STABILITY AND FOSTER COMPETITION).

DODD 5000.1, MAJOR SYSTEM ACQUISITIONS

HIGHLIGHTS:

- ANALYSIS OF MISSION AREAS -- INCREASED EMPHASIS.
- ALTERNATIVES TO NEW SYSTEM DEVELOPMENT -- JUSTIFY NEED FOR NEW DEVELOPMENTS.
- PHASES OF ACQUISITION PROCESS -- "TAILORING."
- SEC. DEF. DECISIONS

  1. MISSION NEED DETERMINATION
  2. MILESTONE I -- APPROVAL FOR DEMONSTRATION AND VALIDATION PHASE.
  3. MILESTONE II -- APPROVAL FOR FULL-SCALE DEVELOPMENT PHASE.

  MILESTONE III -- (APPROVAL FOR PRODUCTION) -- DOD COMPONENT DECISION.

- DESIGNATION OF MAJOR SYSTEMS BY SEC. DEF. BASED ON:

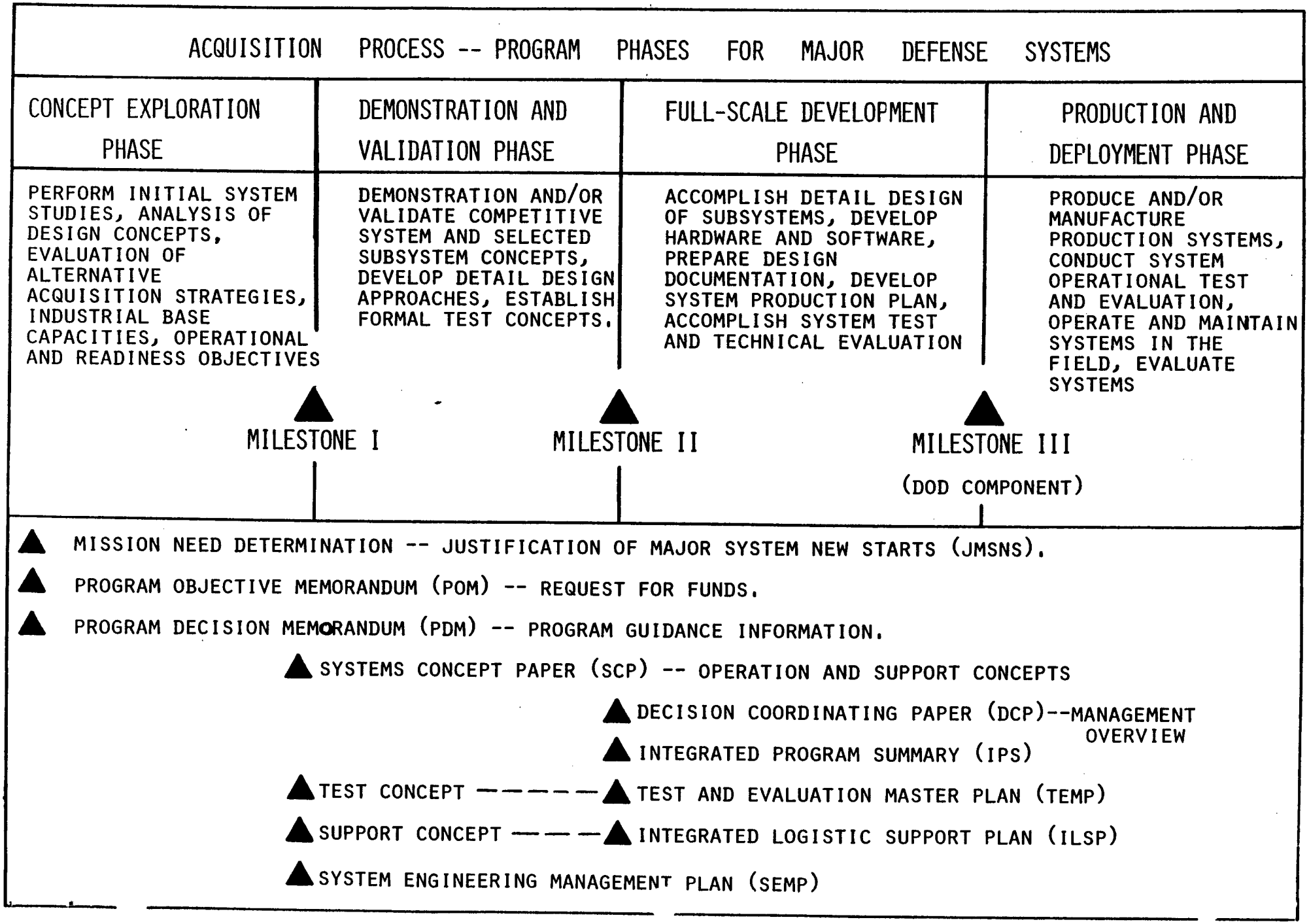
  1. DEVELOPMENT RISK, URGENCY OF NEED, ETC.
  2. JOINT ACQUISITION CONSIDERATIONS.
  3. EXTENT OF RESEARCH AND DEVELOPMENT REQUIREMENTS ($200 MILLION IN RDT & E FUNDS AND $1 BILLION IN PRODUCTION FUNDS).
  4. SIGNIFICANT CONGRESSIONAL INTEREST.

DODD 5000.1, MAJOR SYSTEM ACQUISITIONS

HIGHLIGHTS:

- AFFORDABILITY -- FUNCTION OF COST, PRIORITY, AND AVAILABILITY OF FISCAL RESOURCES.
- ACQUISITION TIME -- MINIMIZING THE TIME FOR SYSTEM ACQUISITIONS.
- TAILORING AND FLEXIBILITY -- EMPHASIZED.
- TEST AND EVALUATION -- CONSIDERED THROUGHOUT ACQUISITION PROCESS.
- READINESS -- EARLY ESTABLISHMENT OF READINESS GOALS.
- DOCUMENTATION:
  1. MISSION NEED . . . JUSTIFICATION FOR MAJOR SYSTEM NEW START (JMSNS).
  2. MILESTONE I . . . SYSTEM CONCEPT PAPER (SCP).
  3. MILESTONE III . . . DECISION COORD. PAPER (DCP) / INTEGRATED PROGRAM SUMMARY (IPS).
- DSARC MEMBERS:
  1. UNDER SECRETARY OF DEFENSE FOR POLICY (USDP).
  2. ASSISTANT SECRETARY OF DEFENSE - MANPOWER, RESERVE AFFAIRS, AND LOGISTICS (ASD/MR&L).
  3. ASSISTANT SECRETARY OF DEFENSE - COMPTROLLER (ASD/C).
  4. DIRECTOR, PROGRAM ANALYSIS AND EVALUATION (DPA&E).
  5. CHAIRMAN, JOINT CHIEFS OF STAFF (JCS).
  6. EACH MILITARY DEPARTMENT SECRETARY.
  7. HEAD OF EACH DOD COMPONENT.

A C Q U I S I T I O N P R O C E S S



SYSTEM ENGINEERING

DEPARTMENT OF DEFENSE REQUIREMENTS

(MIL - STD - 499A ; ENGINEERING MANAGEMENT)

SYSTEM ENGINEERING--SOME DEFINITIONS

SYSTEM ENGINEERING

THE APPLICATION OF SCIENTIFIC AND ENGINEERING EFFORTS TO (1) TRANSFORM AN OPERATIONAL NEED INTO A DESCRIPTION OF SYSTEM PERFORMANCE PARAMETERS AND A PREFERRED SYSTEM CONFIGURATION THROUGH THE USE OF AN ITERATIVE PROCESS OF FUNCTIONAL ANALYSIS, SYNTHESIS, OPTIMIZATION, DEFINITION, DESIGN, TEST, AND EVALUATION; (2) INTEGRATE RELATED TECHNICAL PARAMETERS AND ASSURE COMPATIBILITY OF ALL PHYSICAL, FUNCTIONAL, AND PROGRAM INTERFACES IN A MANNER THAT OPTIMIZES THE TOTAL SYSTEM DEFINITION AND DESIGN; AND (3) INTEGRATE RELIABILITY, MAINTAINABILITY, LOGISTIC SUPPORT, SAFETY, PRODUCIBILITY, SECURITY, SURVIVABILITY, STRUCTURAL INTEGRITY, HUMAN FACTORS, AND OTHER RELATED SPECIALITIES INTO THE TOTAL ENGINEERING EFFORT.

SYSTEM ENGINEERING PROCESS

A LOGICAL SEQUENCE OF ACTIVITIES AND DECISIONS TRANSFORMING AN OPERATIONAL NEED INTO A DESCRIPTION OF SYSTEM PERFORMANCE PARAMETERS AND A PREFERRED SYSTEM CONFIGURATION.

SYSTEM ENGINEERING--SOME DEFINITIONS

SYSTEM ENGINEERING MANAGEMENT

THE MANAGEMENT OF THE ENGINEERING AND TECHNICAL EFFORT REQUIRED TO TRANSFORM A SYSTEM REQUIREMENT INTO AN OPERATIONAL SYSTEM.

SYSTEM ENGINEERING MANAGEMENT PLAN (SEMP)

TO INCLUDE THREE (3) PARTS:

- PART I -- TECHNICAL PROGRAM PLANNING AND CONTROL.
- PART II -- SYSTEM ENGINEERING PROCESS.
- PART III -- ENGINEERING SPECIALTY INTEGRATION.

SYSTEM ENGINEERING MANAGEMENT PLAN (SEMP)

A. PART I - TECHNICAL PROGRAM PLANNING AND CONTROL

- PROGRAM ORGANIZATION, PROCEDURES, WORK BREAKDOWN STRUCTURE (WBS),
- SPECIFICATION TREE, TASK STATEMENTS, SCHEDULES, ETC.
- PROGRAM RISK ANALYSIS.
- SYSTEM TEST PLANNING.
- DECISION AND CONTROL PROCESS.
- TECHNICAL PERFORMANCE MEASUREMENT (TPM).
- TECHNICAL REVIEWS (FORMAL DESIGN REVIEWS).
- DOCUMENTATION CONTROL.
- SUPPLIER/SUBCONTRACTOR REVIEW AND CONTROL.

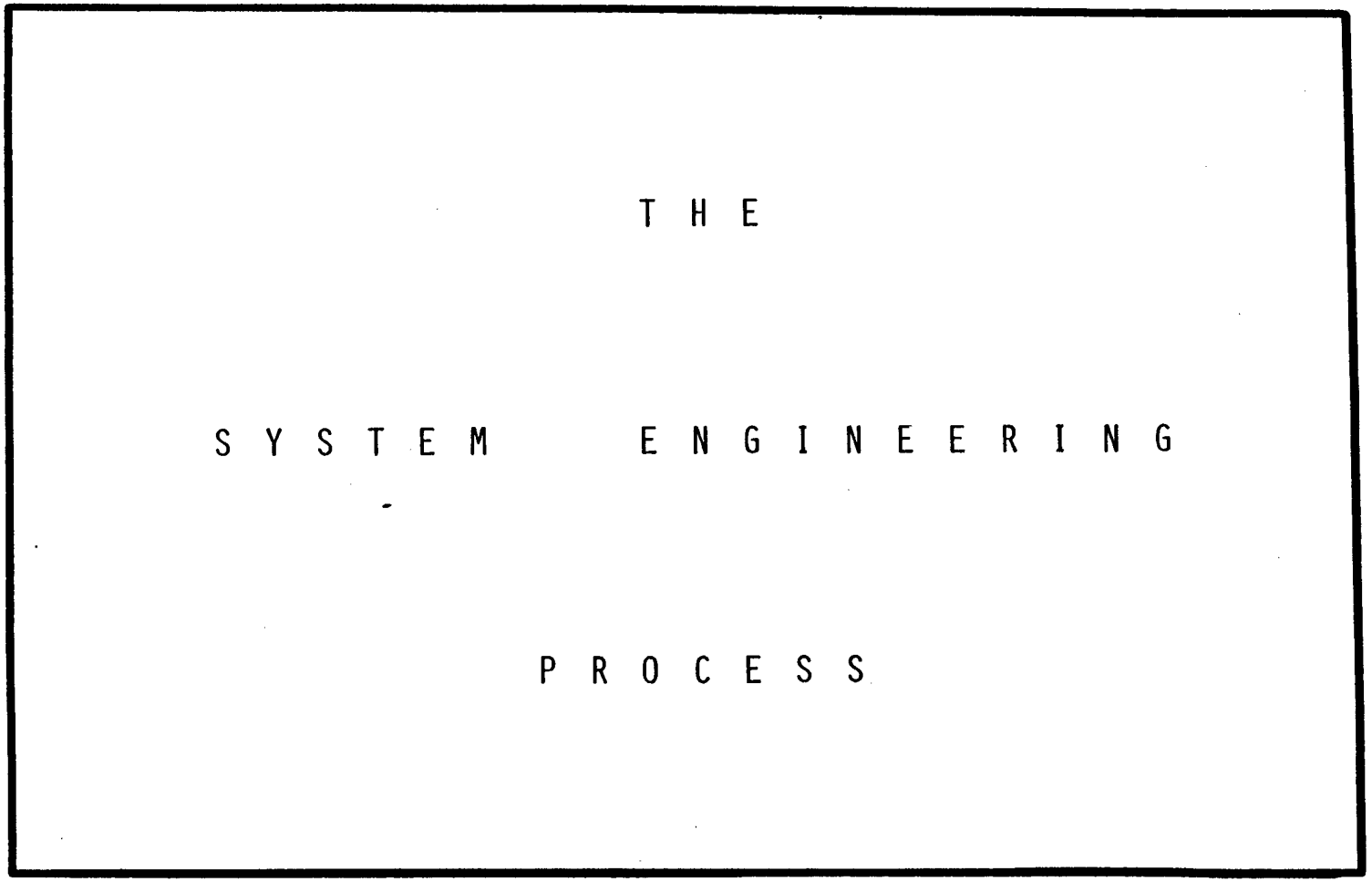
B. PART II - SYSTEM ENGINEERING PROCESS

- SYSTEM OPERATIONAL REQUIREMENTS AND MAINTENANCE CONCEPT (MISSION
- REQUIREMENTS ANALYSIS).
- FUNCTIONAL ANALYSIS.
- ALLOCATION OF REQUIREMENTS.
- SYSTEM SYNTHESIS.
- SYSTEM ANALYSIS AND TRADE-OFFS.
- SYSTEM DESIGN.
- SYSTEM TEST AND EVALUATION.

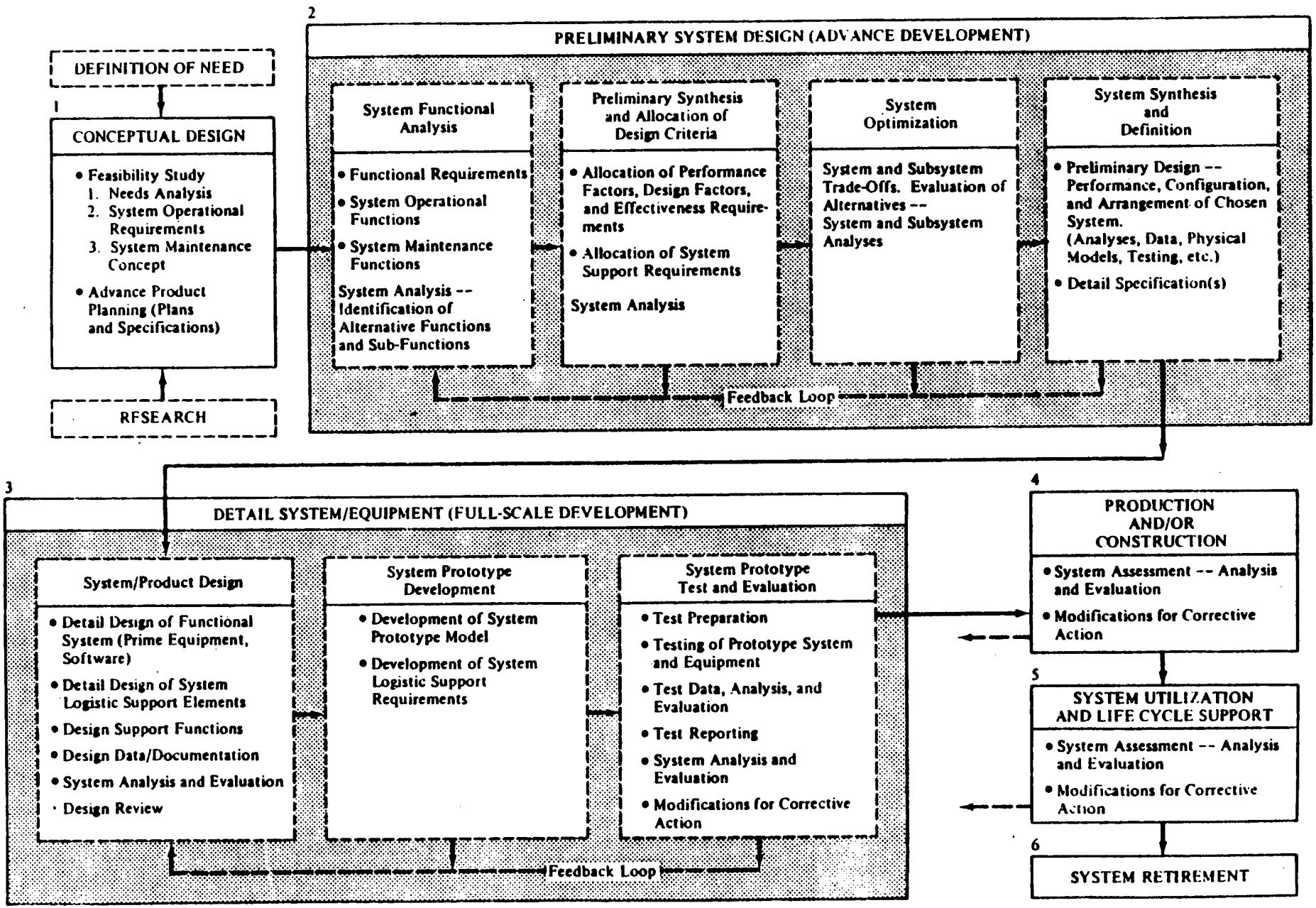
C. PART III - ENGINEERING SPECIALTY INTEGRATION

THE INTEGRATION AND COORDINATION OF PROGRAM EFFORTS FOR THE ENGINEERING SPECIALTY AREAS: RELIABILITY, MAINTAINABILITY, HUMAN FACTORS, SAFETY, LOGISTIC SUPPORT VALUE ENGINEERING, SURVIVABILITY, RANSPORTABILITY, PRODUCIBILITY, AND OTHERS.

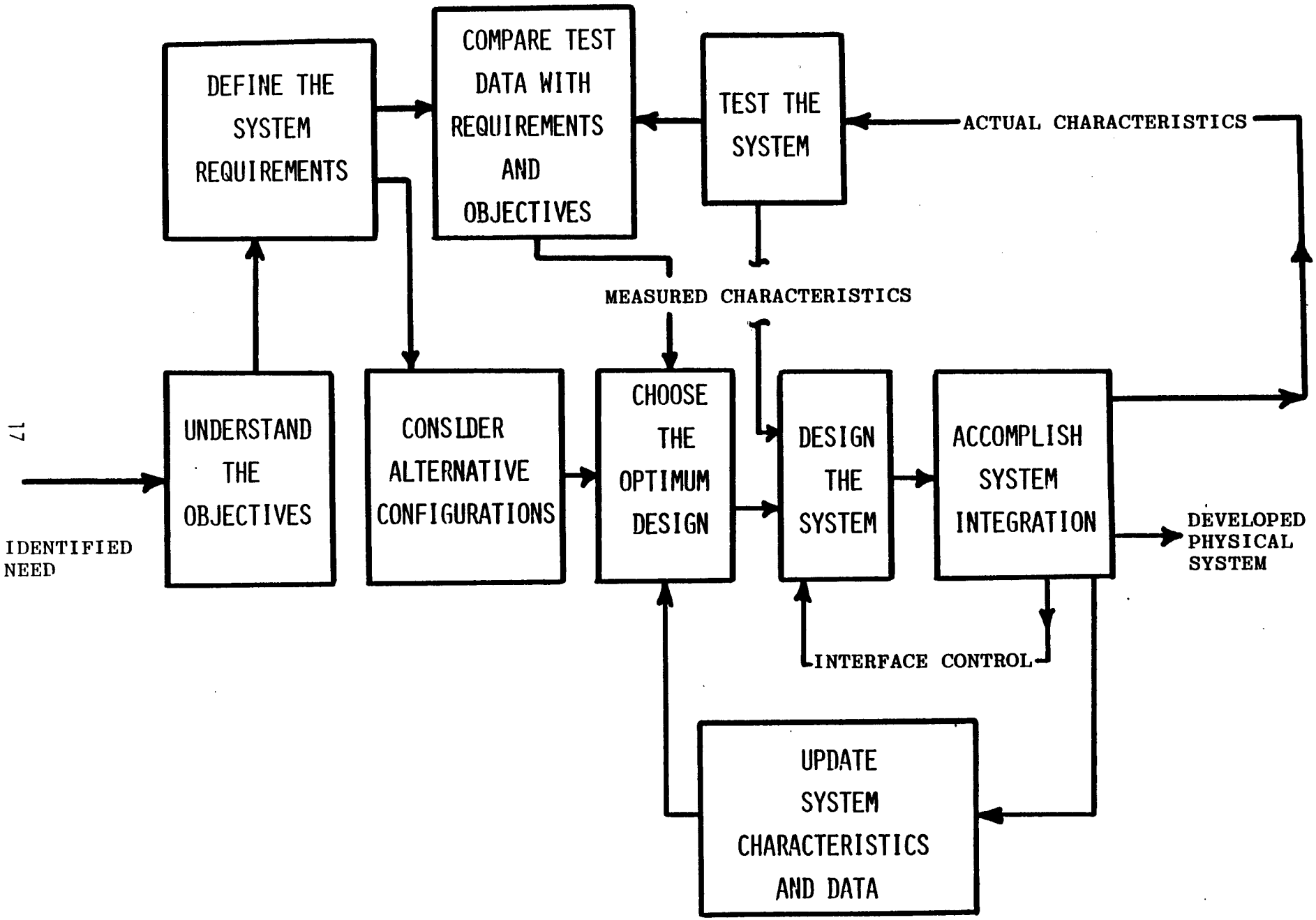
OBJECTIVE - TOTAL INTEGRATED ENGINEERING EFFORT.


THE
SYSTEM ENGINEERING
PROCESS

SYSTEM DESIGN EVOLUTION



FEEDBACK NATURE OF THE SYSTEM ENGINEERING PROCESS



SYSTEM OPERATIONAL

REQUIREMENTS

AND

MAINTENANCE CONCEPT

MISSION NEED DETERMINATION

BRIEF DESCRIPTION OF THE NEED IN TERMS OF MISSION CAPABILITY. IT IDENTIFIES AND DEFINES:

- THE DEFICIENCY IN THE EXISTING CAPABILITY, AND THE NEED FOR A NEW SYSTEM BASED ON A FORECASTED THREAT (DEFICIENCY MAY INCLUDE: INADEQUATE MISSION PERFORMANCE OR SYSTEM READINESS, INADEQUATE LOGISTIC SUPPORT REQUIREMENTS, EXCESSIVE OWNERSHIP COSTS, ETC.).

- THE RELATIVE PRIORITY FOR THE NEW SYSTEM CAPABILITY.

- THE DATE THAT THE NEW CAPABILITY MUST BE FIELDED IN ORDER TO ADEQUATELY MEET THE THREAT.

- THE GENERAL MAGNITUDE OF THE ACQUISITION RESOURCES AVAILABLE FOR INVESTING IN THE NEW SYSTEM CAPABILITY

<u>DOCUMENTATION</u> -- JUSTIFICATION FOR MAJOR SYSTEM NEW START (JMSNS). PROBLEM SOLUTIONS SHALL NOT BE SPECIFIED, NOR HARDWARE / SOFTWARE CONFIGURATIONS. (REFERENCE: DODD 5000.1, "MAJOR SYSTEM ACQUISITIONS," MARCH 1982).

SYSTEM OPERATIONAL REQUIREMENTS

OPERATIONAL REQUIREMENTS EVOLVE FROM AN IDENTIFIED NEED, AND INCLUDE COVERAGE OF:

- SYSTEM PERFORMANCE CHARACTERISTICS

  MISSION SCENARIO(S), MISSION FREQUENCY AND DURATION, MODES OF OPERATION, RANGE, ACCURACY, WEIGHT AND SPACE ENVELOPE, ETC.

- SYSTEM / EQUIPMENT DEPLOYMENT, UTILIZATION, AND OPERATIONAL HORIZON PERIOD

  QUANTITY OF SYSTEMS AND OPERATIONAL SITES, GEOGRAPHICAL LOCATION, SYSTEM UTILIZATION (HOUR OR CYCLES), OPERATIONAL LIFE CYCLE, ETC.

- EFFECTIVENESS FACTORS

  AVAILABILITY, RELIABILITY, MAINTAINABILITY, SUPPORTABILITY, COST, ETC.

- ENVIRONMENTAL REQUIREMENTS

  TRANSPORTATION MODES AND OPERATING ENVIRONMENTAL PROFILES -- TEMPERATURE CYCLES, VIBRATION, SHOCK, MOUNTAINOUS TERRAIN, TROPICS, ETC.

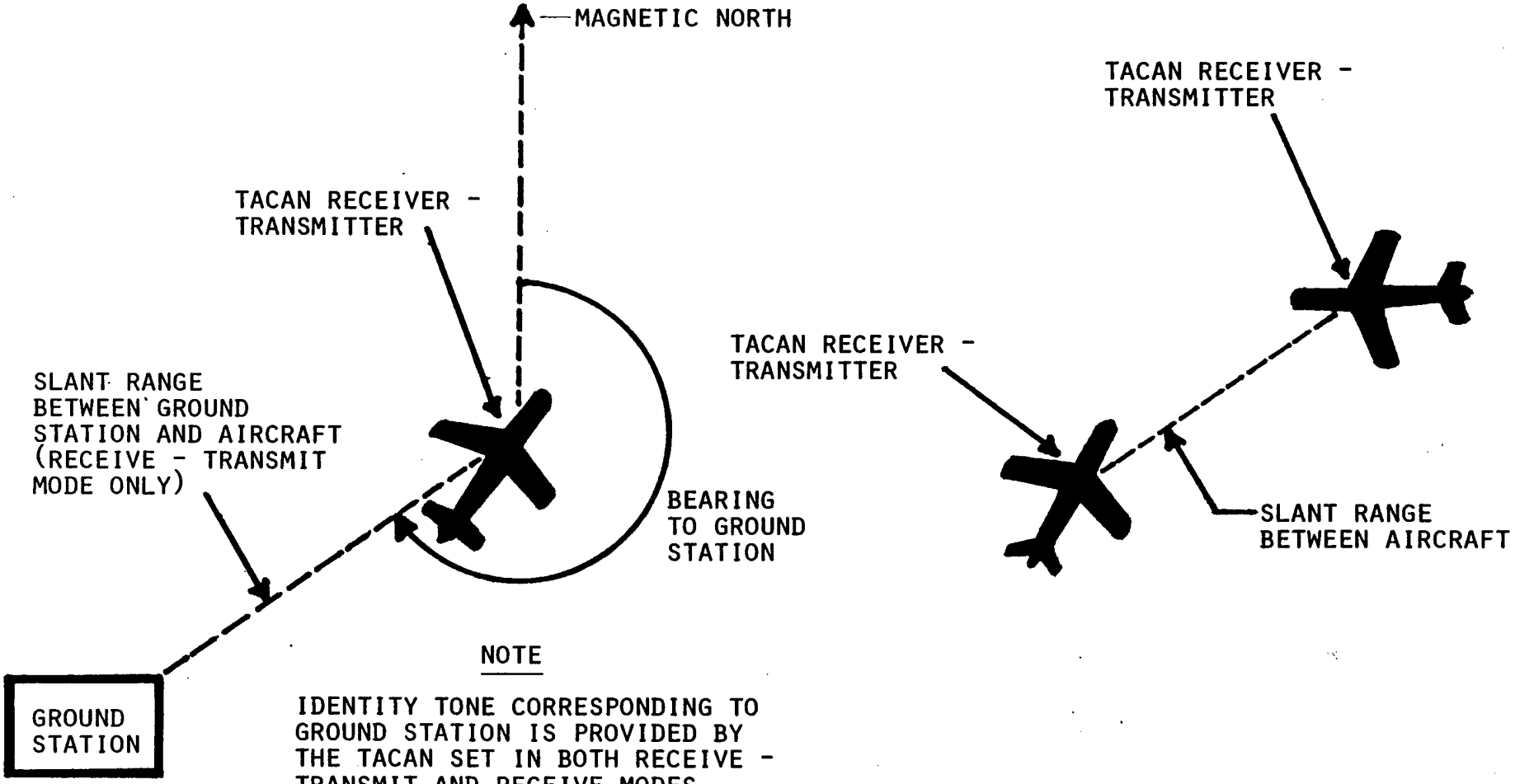
HOW WILL THE SYSTEM BE USED ?

SYSTEM "XYZ" PERFORMANCE REQUIREMENT

THE EXISTING TACTICAL AIR NAVIGATION CAPABILITY FOR THE "ABC" AND "XYZ" AIRCRAFT DOES NOT PROVIDE AN "AIR-TO-AIR" MODE OF OPERATION, AND THE CURRENT "AIR-TO-GROUND" MODE NEEDS TO BE UPGRADED IN TERMS OF BOTH RANGE AND ACCURACY.

THERE IS A NEED FOR A NEW AIRBORNE, OMNIBEARING, DISTANCE - MEASURING NAVIGATION DEVICE CAPABLE OF PROVIDING A CONTINUOUS INDICATION OF THE BEARING AND RANGE OF AN AIRCRAFT FROM A SELECTED TACAN GROUND STATION, OR FROM ANOTHER COOPERATING, SIMILARLY EQUIPPED AIRCRAFT. THE DEVICE MUST HAVE A 300-MILE RANGE, WITH AN ACCURACY OF 0.1 MILE (BETWEEN ZERO AND 50 MILES) AND 0.2 MILE (BETWEEN 51 AND 300 MILES). THE BEARING TOLERANCE MUST NOT EXCEED ± 2.0 DEGREES.

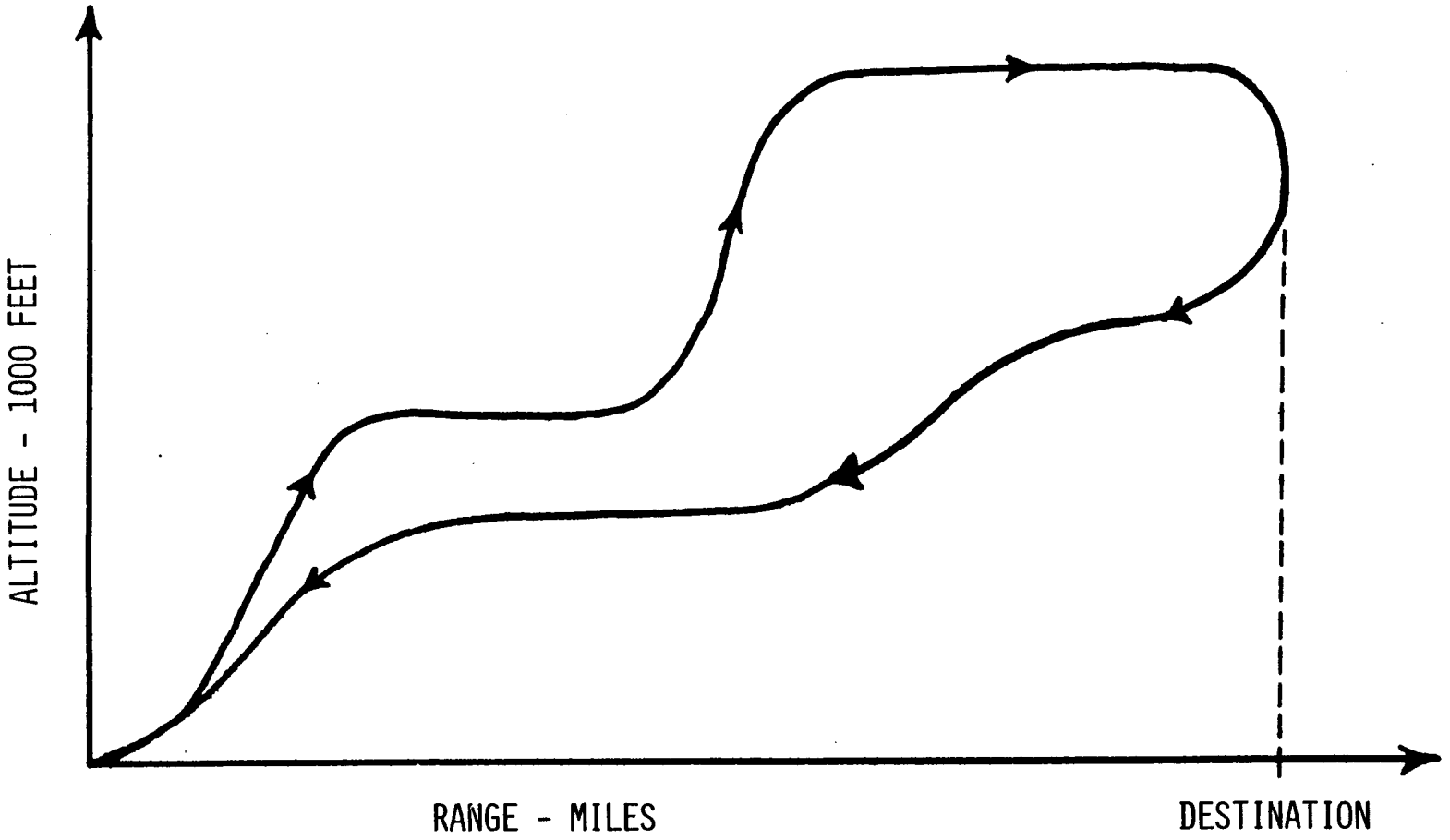
MODES OF OPERATION



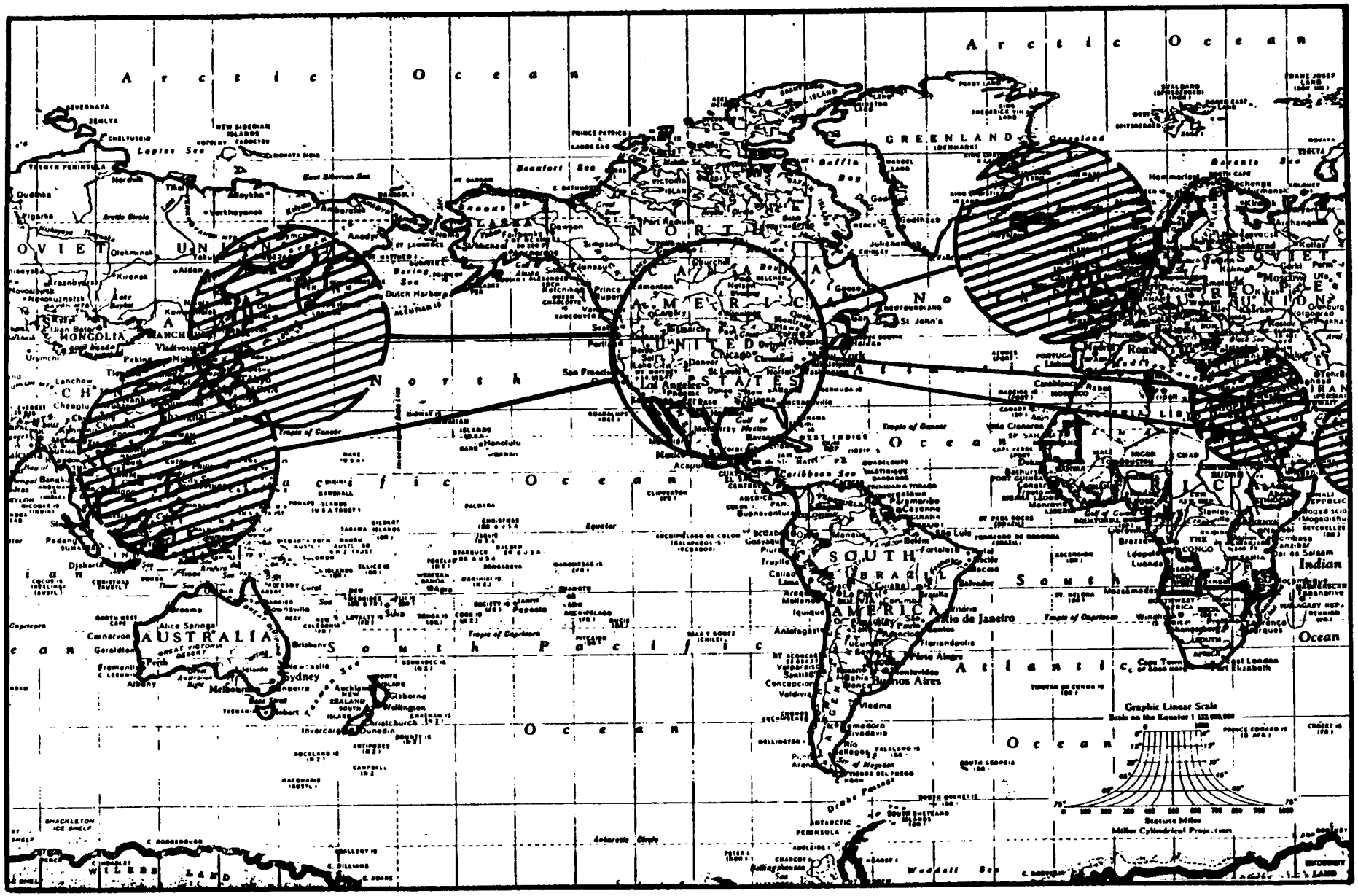
RECEIVE - TRANSMIT AND RECEIVE MODES

AIR - TO - AIR MODES

SYSTEM "XYZ" MISSION PROFILE/SCENARIO



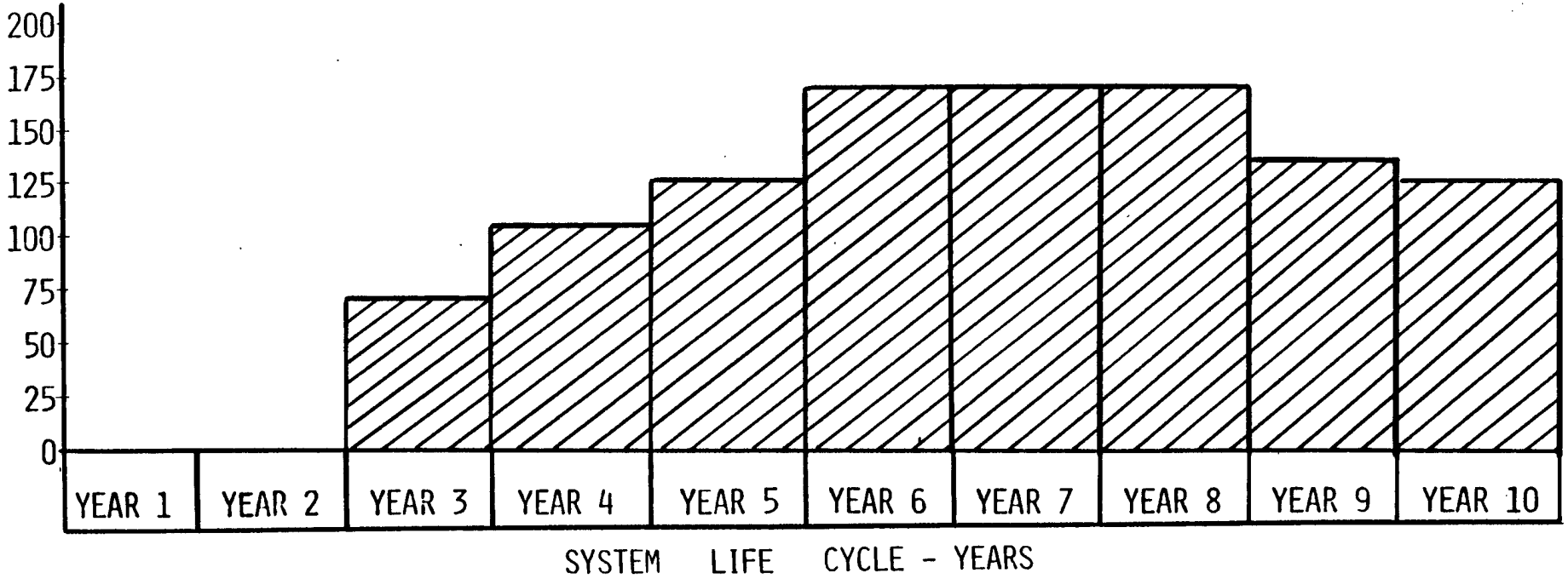
SYSTEM OPERATIONAL REQUIREMENTS -- GEOGRAPHICAL DEPLOYMENT



SYSTEM "X Y Z" OPERATIONAL REQUIREMENTS -- GEOGRAPHICAL DEPLOYMENT

OPERATIONAL ZONES	YEAR NUMBER										TOTAL
	1	2	3	4	5	6	7	8	9	10	
1. CONTINENTAL USA	-	-	10	20	40	60	60	60	35	25	310
2. FAR EAST NO. 1	-	-	12	24	24	24	24	24	24	24	180
3. FAR EAST NO. 2	-	-	12	12	12	24	24	24	24	24	156
4. NORTH ATLANTIC	-	-	12	24	24	24	24	24	24	24	180
5. NEAR EAST	-	-	12	12	12	24	24	24	12	12	132
6. INDIAN OCEAN	-	-	12	12	12	12	12	12	12	12	96
TOTAL	-	-	70	104	124	168	168	168	131	121	1054

AVERAGE UTILIZATION -- 4 HOURS PER DAY, 365 DAYS PER YEAR.



SYSTEM SUPPORT REQUIREMENTS

MAINTENANCE CONCEPT AND LOGISTIC SUPPORT REQUIREMENTS EVOLVE FROM OPERATIONAL REQUIREMENTS, AND INCLUDE COVERAGE OF:

- LEVELS OF MAINTENANCE

  ORGANIZATION (LINE), INTERMEDIATE (SHOP), AND OVERHAUL AND REPAIR (FACTORY OR DEPOT).

- MAINTENANCE RESPONSIBILITY

  MAINTENANCE AND SUPPORT PROVIDED BY USER, PRODUCER, SUPPLIER, ETC., AND THE TIME PERIOD OR DURATION OF SUPPORT.

- LOGISTICS SUPPORT REQUIREMENTS

  TYPE OF SUPPORT AND TEST EQUIPMENT, SUPPLY SUPPORT (SPARE PARTS, INVENTORY REQUIREMENTS), PERSONNEL QUANTITIES AND SKILLS, TRAINING, FACILITIES, TRANSPORTATION AND HANDLING REQUIREMENTS, SOFTWARE, DATA, ETC.

- EFFECTIVENESS REQUIREMENTS

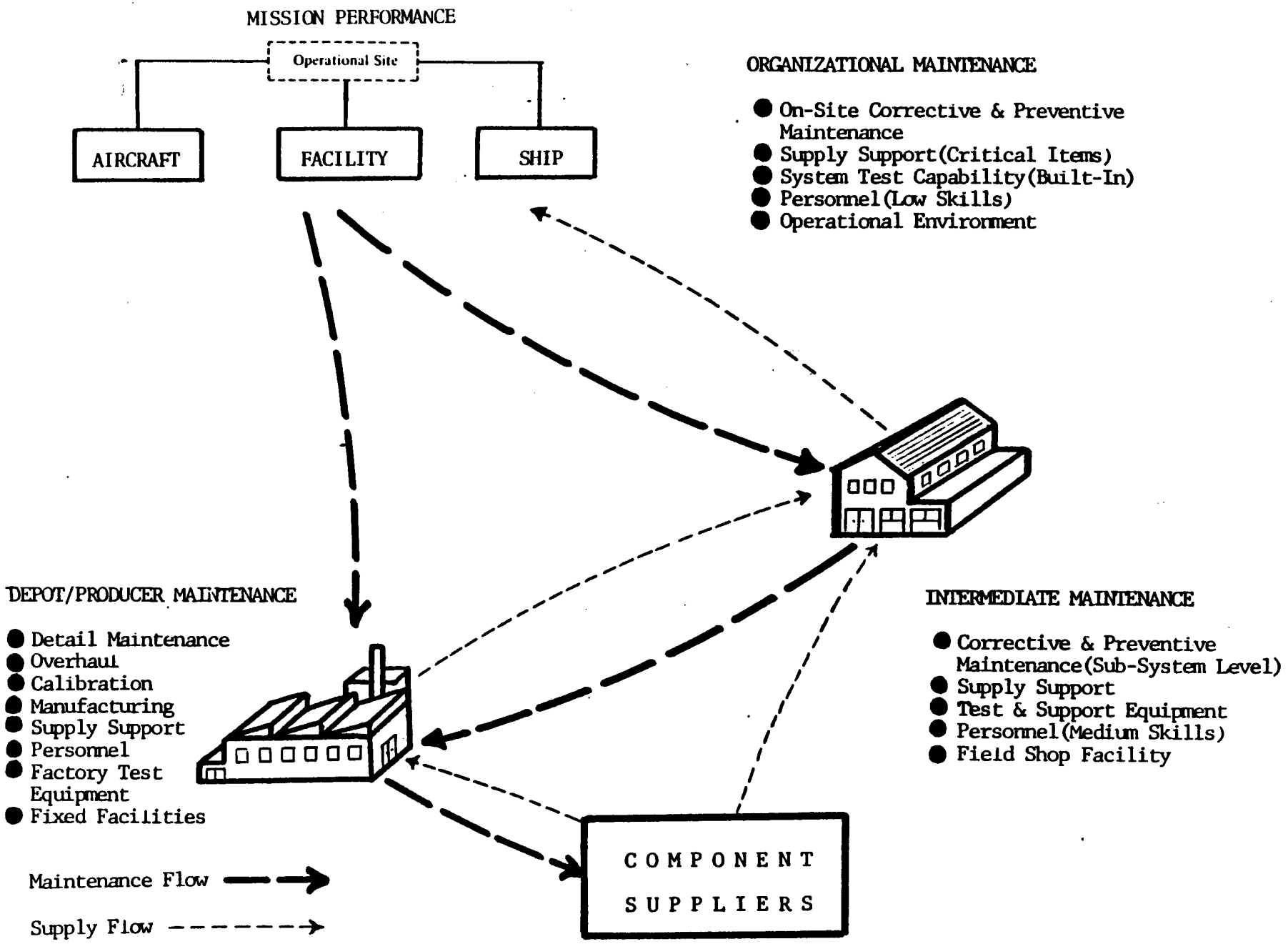
  SUPPLY RESPONSIVENESS (SPARES AVAILABLE, TIME TO ACQUIRE SPARES), TEST EQUIPMENT UTILIZATION AND AVAILABILITY, PERSONNEL EFFECTIVENESS, MAINTENANCE DOWN TIME, MEAN TIME BETWEEN MAINTENANCE, TURNAROUND TIME, ETC.

- ENVIRONMENTAL REQUIREMENTS

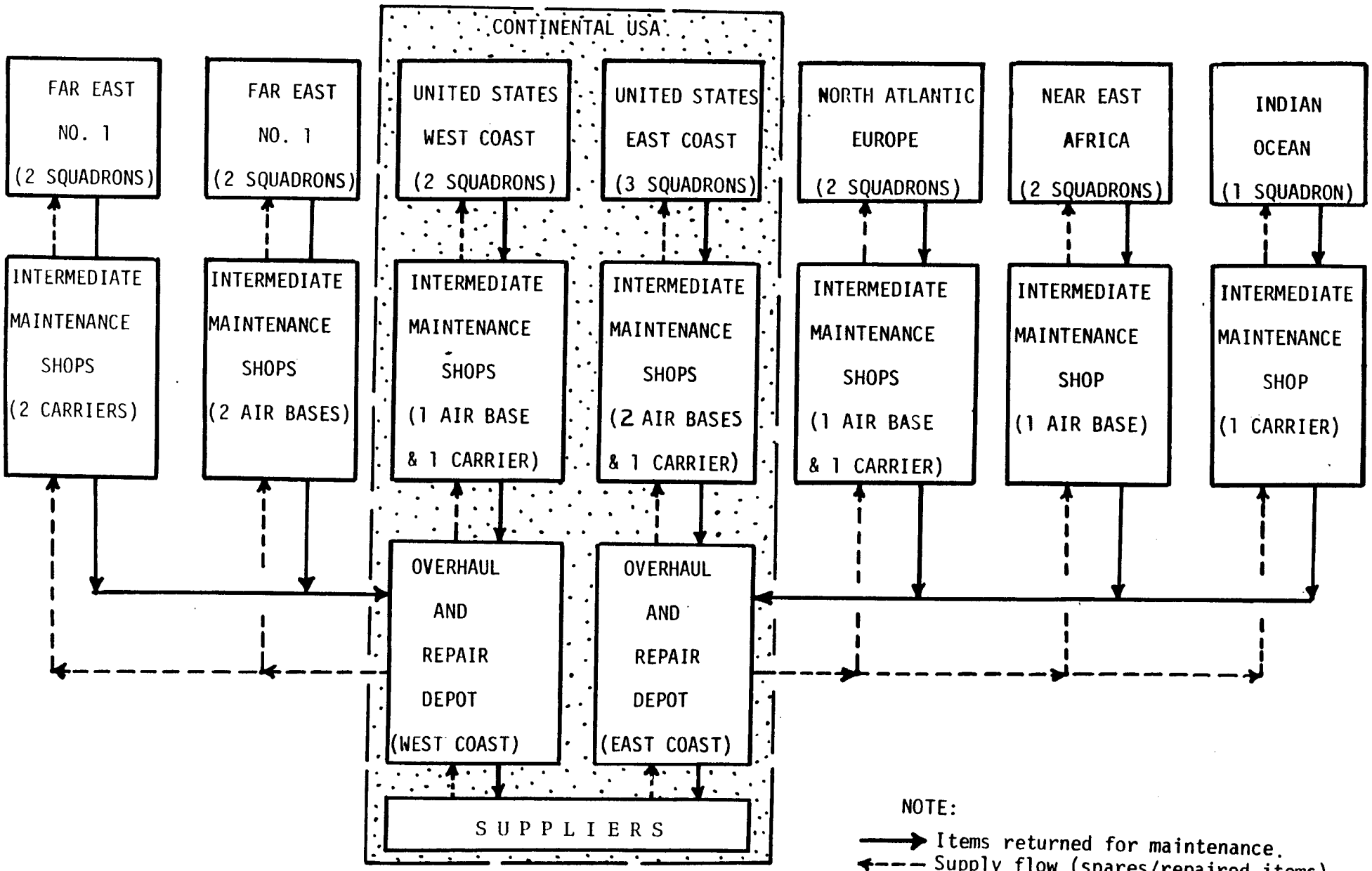
  TRANSPORTATION AND HANDLING ENVIRONMENTS, STORAGE ENVIRONMENTS, MAINTENANCE ENVIRONMENTAL PROFILES (TEMPERATURE, HUMIDITY, VIBRATION, SHOCK).

HOW WILL THE SYSTEM/PRODUCT BE SUPPORTED?

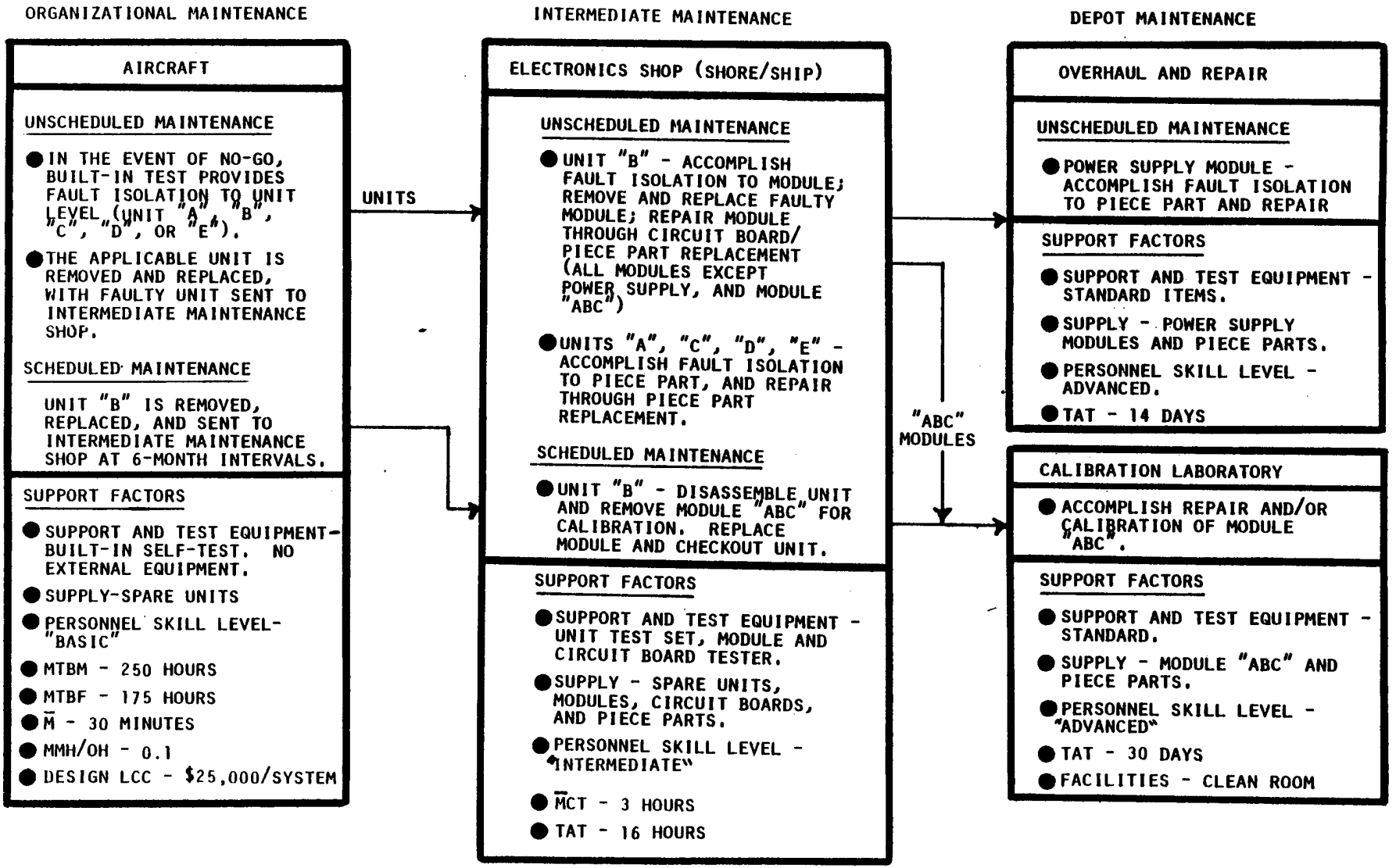
SYSTEM OPERATIONAL / . . INTENANCE FLOW



TOP-LEVEL SYSTEM "XYZ" SUPPORT CONCEPT



SYSTEM "XYZ" MAINTENANCE CONCEPT FLOW (PROJECTED)



SYSTEM ENVIRONMENTAL REQUIREMENTS

OPERATIONAL USE ENVIRONMENT AND MAINTENANCE ENVIRONMENT

- MISSION SCENARIO ENVIRONMENT
- TRANSPORTATION AND HANDLING ENVIRONMENT
- STORAGE ENVIRONMENT
- MAINTENANCE ENVIRONMENT

TEMPERATURE RANGE AND CYCLING, HUMIDITY EXTREMES AND CYCLING, VIBRATION AND SHOCK, SAND AND DUST, SALT SPRAY, TOXIC SUBSTANCES (AIR POLLUTION / WATER POLLUTION).

OBJECTIVE: ADHERENCE TO PERSONNEL AND EQUIPMENT SAFETY, AND ELIMINATION OF SYSTEM DEGRADATION DUE TO ENVIRONMENTAL CONDITIONS.

E F F E C T I V E N E S S

M E A S U R E S

EFFECTIVENESS MEASURES

EFFECTIVENESS REQUIREMENTS WILL VARY WITH THE TYPE OF SYSTEM, THE NATURE OF ITS MISSION, AND MAY INCLUDE A COMBINATION OF:

A. RELIABILITY FACTORS

- THE RELIABILITY FUNCTION (R), OR PROBABILITY OF SUCCESS (P)
- THE FAILURE RATE (λ)
- MEAN TIME BETWEEN FAILURE (MTBF)
- MEAN TIME TO FAILURE (MTTF)

B. MAINTAINABILITY FACTORS

1. MAINTENANCE FREQUENCY FACTORS

- MEAN TIME BETWEEN MAINTENANCE (MTBM) -- FUNCTION OF $MTBM_U$ AND $MTBM_S$ (EQUIVALENT TO MTBMA).
- MEAN TIME BETWEEN REPLACEMENT (MTBR).
- MAINTENANCE RATE (MAINTENANCE ACTIONS / MONTH OR YEAR) -- FUNCTION OF UNSCHEDULED MAINTENANCE RATE ($1/MTBM_U$) AND SCHEDULED MAINTENANCE RATE ($1/MTBM_S$)

EFFECTIVENESS MEASURES

B. MAINTAINABILITY FACTORS (CONTINUED)

2. MAINTENANCE ELAPSED TIME FACTORS

- MEAN CORRECTIVE MAINTENANCE TIME ($\bar{M}_{CT}$) -- EQUIVALENT TO MEAN TIME TO REPAIR (MTTR).
- MEAN PREVENTIVE MAINTENANCE TIME ($\bar{M}_{PT}$).
- MEDIAN CORRECTIVE AND PREVENTIVE MAINTENANCE TIMES ($\tilde{M}_{CT}$, $\tilde{M}_{PT}$).
- MEAN ACTIVE MAINTENANCE TIME ($\bar{M}$) -- EQUIVALENT TO MEAN ACTIVE MAINTENANCE DOWNTIME (MAMDT).
- MAINTENANCE DOWNTIME (MDT) -- FUNCTION OF MEAN ACTIVE MAINTENANCE TIME ($\bar{M}$), MEAN LOGISTICS DELAY TIME ($\overline{LDT}$), AND MEAN ADMINISTRATIVE DELAY TIME ($\overline{ADT}$).
- TURNAROUND TIME (TAT).

3. MAINTENANCE LABOR FACTORS

- MAINTENANCE MANHOURS PER SYSTEM OPERATING HOUR (MMH/OH).
- MAINTENANCE MANHOURS PER MONTH (MMH/MO), OR YEAR (MMH/YR).
- MAINTENANCE MANHOURS PER MAINTENANCE ACTION (MMH/MA).
- UNSCHEDULED MAINTENANCE MANHOURS.
- SCHEDULED MAINTENANCE MANHOURS.

EFFECTIVENESS MEASURES

C. LOGISTIC SUPPORT FACTORS

- SUPPORT AND TEST EQUIPMENT -- REPAIRABLE ITEM ARRIVAL RATE, RELIABILITY AND AVAILABILITY OF TEST EQUIPMENT, WAITING TIME IN THE QUE, ON-STATION TEST TIME, TEST THOROUGHNESS, CALIBRATION REQUIREMENTS, ETC.
- SUPPLY SUPPORT -- SPARES LOCATION AND AVAILABILITY, SPARES PROCESSING TIME, INVENTORY CONSIDERATIONS (ITEM CONSUMPTION RATE, CONDEMNATION RATE, INVENTORY LEVEL, PROCUREMENT LEADTIME, ECONOMIC ORDER QUANTITIES, PROVISIONING CYCLES, SAFETY STOCK LEVELS, INVENTORY POLICIES, ETC.).
- MANPOWER AND PERSONNEL -- QUANTITY OF PERSONNEL, SKILL LEVEL REQUIREMENTS, PERSONNEL ERROR RATES, MAINTAINABILITY LABOR FACTORS, SAFETY FACTORS, DIRECT TO INDIRECT PERSONNEL RATIOS, ATTRITION RATES, ETC.
- TRAINING AND TRAINING DEVICES -- TRAINING LEVELS, TRAINING RATES (TOTAL PERSONNEL / YEAR), TRAINING LOAD (MAN DAYS / YEAR), RELIABILITY AND AVAILABILITY OF TRAINING EQUIPMENT / DEVICES, ETC.
- FACILITIES -- MAINTENANCE PROCESS TIME, FACILITY UTILIZATION (%), ENERGY CONSUMPTION, ETC.
- TRANSPORTATION AND HANDLING -- TRANSPORTATION MODE RELIABILITY, HANDLING CAPACITY, TRANSPORTATION RATE, TRANSPORTATION TIME, DAMAGE / SPOILAGE RATE, SAFETY FACTOR, ETC.

EFFECTIVENESS MEASURES

D. AVAILABILITY FACTORS

- INHERENT AVAILABILITY (A_i)
- ACHIEVED AVAILABILITY (A_a)
- OPERATIONAL AVAILABILITY (A_o)

E ECONOMIC FACTORS

- RESEARCH AND DEVELOPMENT COST ($)
- PRODUCTION / CONSTRUCTION COST ($)
- OPERATION AND SUPPORT COST ($)
- RETIREMENT AND DISPOSAL COST ($)
- LIFE CYCLE COST ($)
- DESIGN TO COST ($)

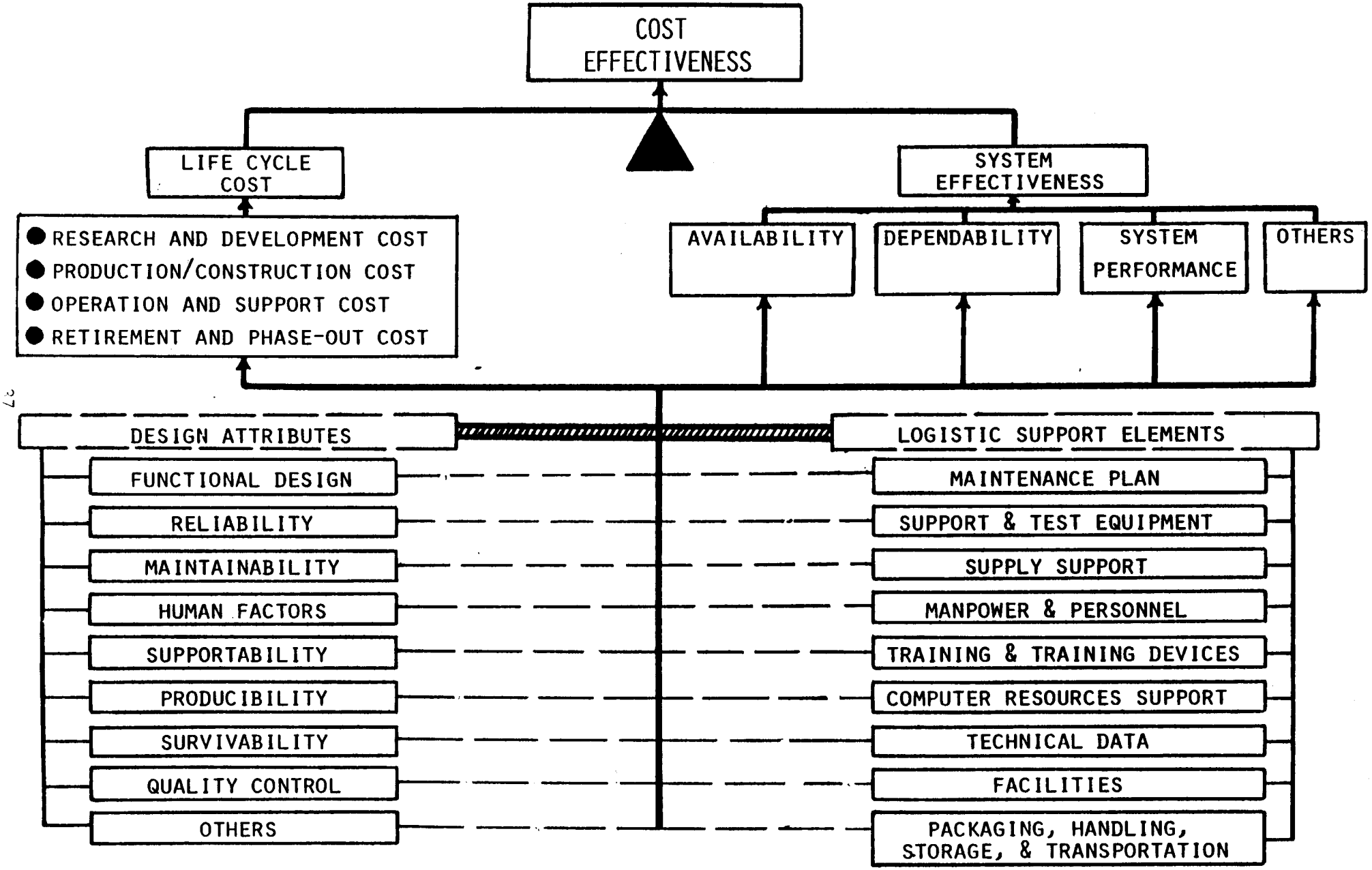
F. EFFECTIVENESS FACTORS

- SYSTEM EFFECTIVENESS
- COST EFFECTIVENESS

SYSTEM "XYZ" EFFECTIVENESS REQUIREMENTS

- SYSTEM PERFORMANCE SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF SPECIFICATION "S – XYZ."
- THE SYSTEM MTBM SHALL BE 175 HOURS (OR GREATER), AND THE MTBF SHALL BE 250 HOURS (OR GREATER).
- THE SYSTEM $\bar{M}$ SHALL BE 30 MINUTES (OR LESS)
- THE MMH / OH AT THE SYSTEM LEVEL SHALL NOT EXCEED 0.1.
- THE SYSTEM SHALL INCORPORATE A BUILT-IN SELF-TEST CAPABILITY THAT WILL ISOLATE A FAULT TO THE APPLICABLE UNIT IN 10 MINUTES OR LESS WITH A 99% SELF-TEST THOROUGHNESS. THE INCORPORATION OF A BUILT-IN SELF-TEST CAPABILITY SHALL NOT DEGRADE OVERALL SYSTEM RELIABILITY BY MORE THAN ONE (1) PERCENT.
- MAINTENANCE AT THE SYSTEM LEVEL SHALL BE ACCOMPLISHED BY A TECHNICIAN WITH A "BASIC" SKILL LEVEL (AS DEFINED IN "NAVMAT ABC"), WITH A ERROR RATE NOT TO EXCEED ONE (1) PERCENT.
- THE SYSTEM SHALL BE DESIGNED TO A UNIT LIFE CYCLE COST OF $25,000.

EFFECTIVENESS RELATIONSHIPS



FUNCTIONAL ANALYSIS

AND

ALLOCATION OF REQUIREMENTS

SYSTEM FUNCTIONAL ANALYSIS

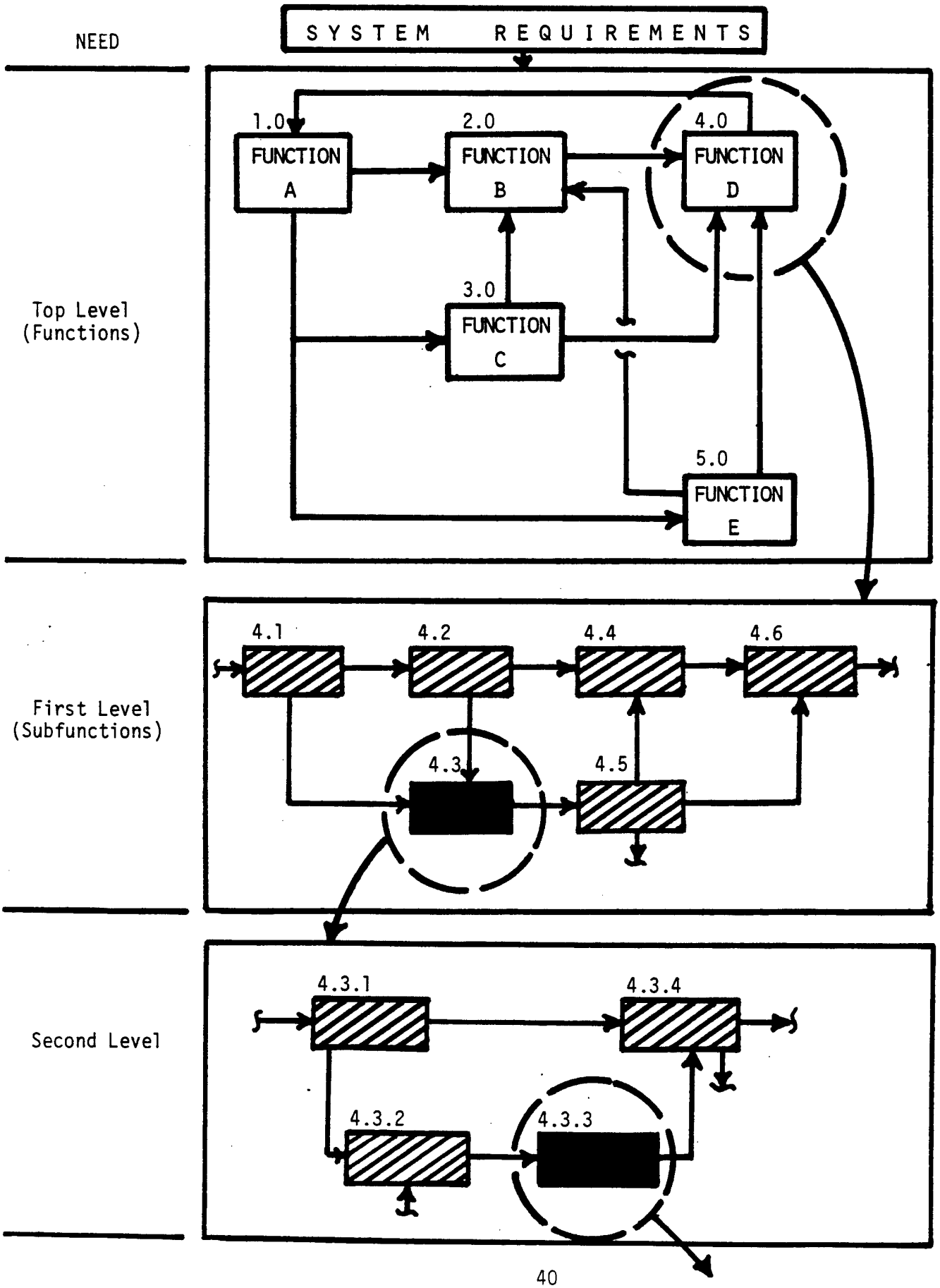
FUNCTIONAL ANALYSIS : THE PROCESS OF TRANSLATING SYSTEM OPERATIONAL AND SUPPORT REQUIREMENTS INTO SPECIFIC QUALITATIVE AND QUANTITATIVE DESIGN REQUIREMENTS. THIS PROCESS IS ITERATIVE, AND IS ACCOMPLISHED THROUGH THE DEVELOPMENT OF FUNCTIONAL FLOW DIAGRAMS.

1. OPERATIONAL FUNCTIONS -- FUNCTIONS ASSOCIATED WITH FULFILLING MISSION REQUIREMENTS (E.G., "PREPARE AIRCRAFT FOR FLIGHT": "STEER SHIP FROM POINT A TO POINT B"; "ACCOMPLISH COMMUNICATION OF INFORMATION 7 DAYS PER WEEK, 6 HOURS PER DAY"; ETC.).

2. MAINTENANCE FUNCTIONS -- FUNCTIONS, WHICH EVOLVE FROM OPERATIONAL FUNCTIONS, AND ARE ASSOCIATED WITH SYSTEM MAINTENANCE AND SUPPORT (E.G., "TRANSPORT UNIT A TO THE INTERMEDIATE SHOP"; "REPAIR MODULE ABC"; "CALIBRATE TEST SET"; ETC.).

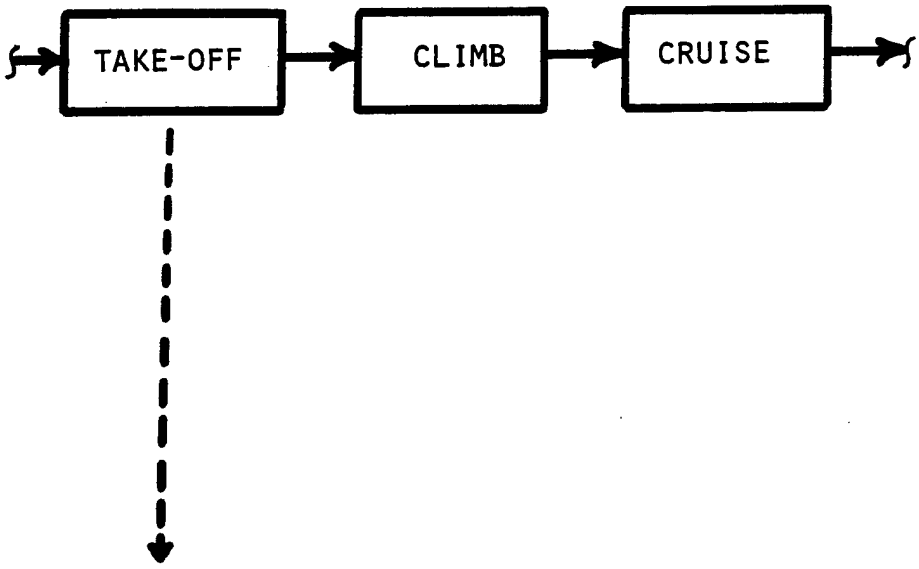
FUNCTIONS MAY BE ACCOMPLISHED THROUGH MANUAL AND/OR AUTOMATIC MEANS, AND REQUIRE THE EXPENDITURE OF RESOURCES.

SYSTEM FUNCTIONAL INDENTURE LEVELS



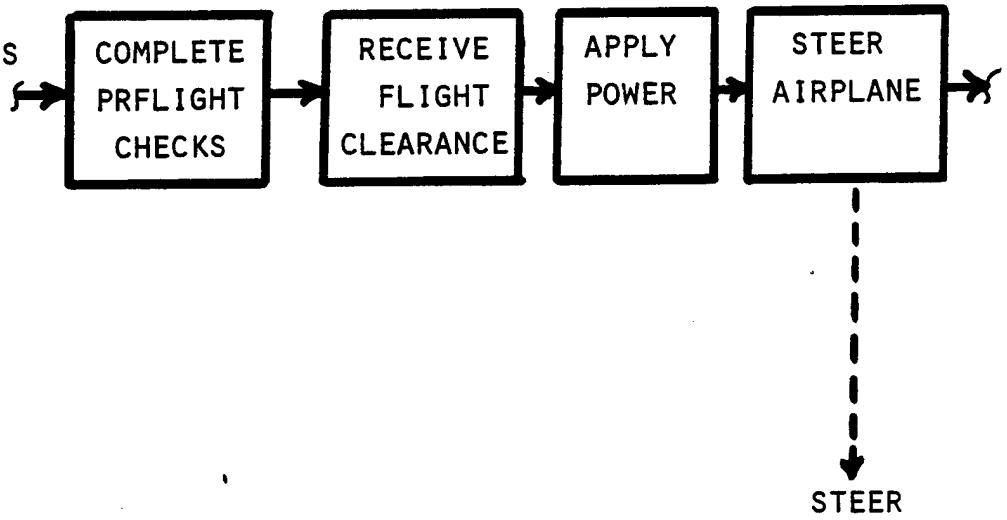
INDENTURE LEVELS OF OPERATING FUNCTIONS

FIRST LEVEL: INVOLVES THE LOGICAL GROSS DIVISION OF ACTIVITIES INTO MISSION PHASES PERFORMED DURING THE TOTAL MISSION.



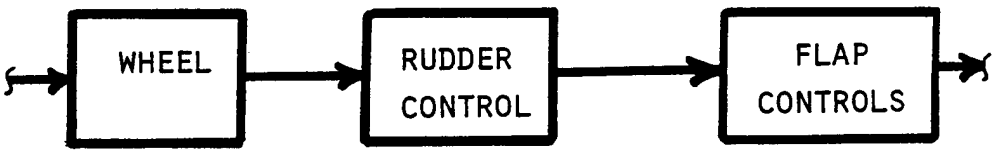
TAKE-OFF

SECOND LEVEL: INVOLVES ALL MAJOR OPERATING FUNCTIONS TO BE PERFORMED WITHIN EACH MISSION PHASE.



STEER

THIRD LEVEL: INVOLVES THE MOST DETAILED ANALYSIS OF JOBS OR TASKS THAT MUST BE PERFORMED TO SUCCESSFULLY ACHIEVE EACH SUBFUNCTION WITHIN EACH MISSION PHASE.

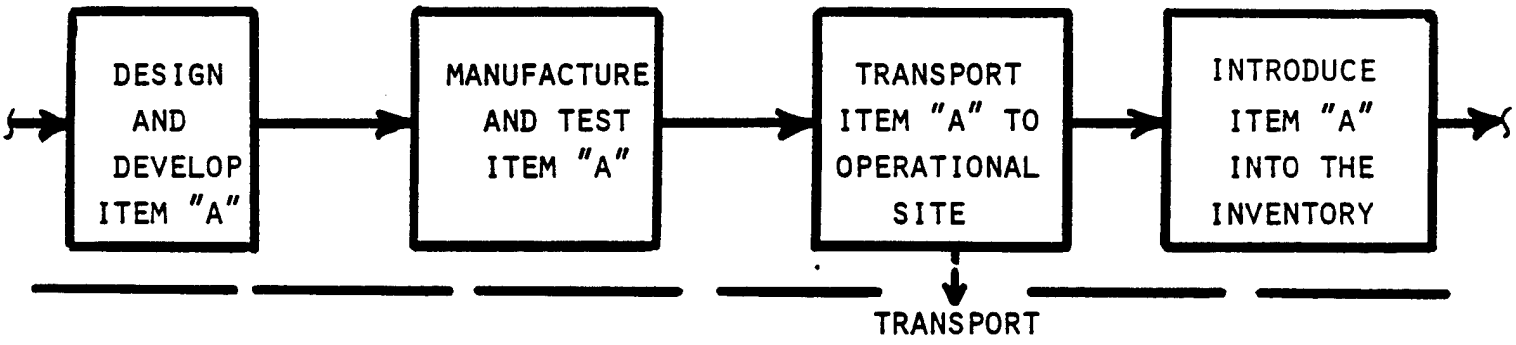


1. MAINTAIN NOSE WHEEL ± 0.1 DEGREES DURING TAKE-OFF.

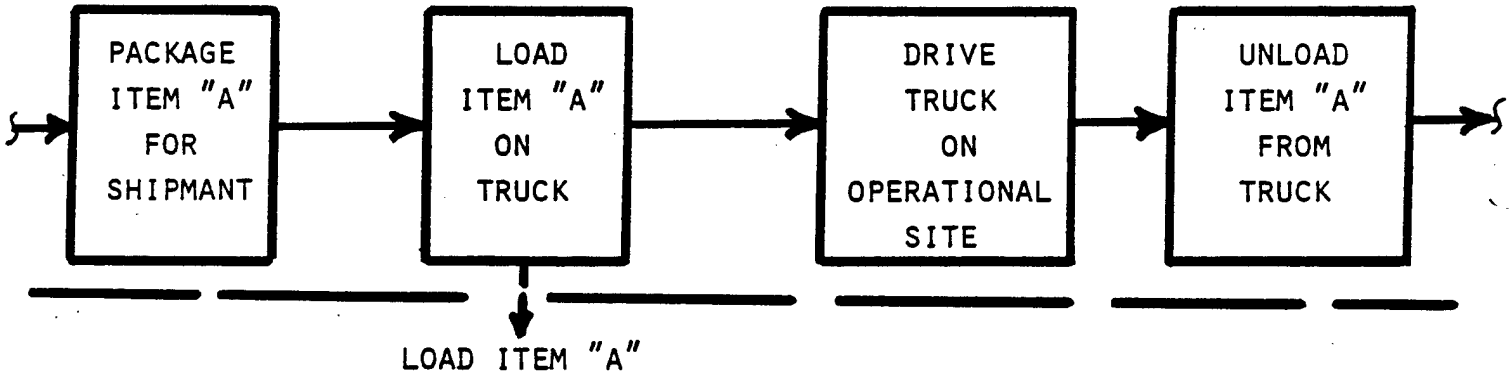
2. PULL ON WHEEL SHALL NOT EXCEED 50 POUNDS.

INDENTURE LEVELS OF OPERATING FUNCTIONS

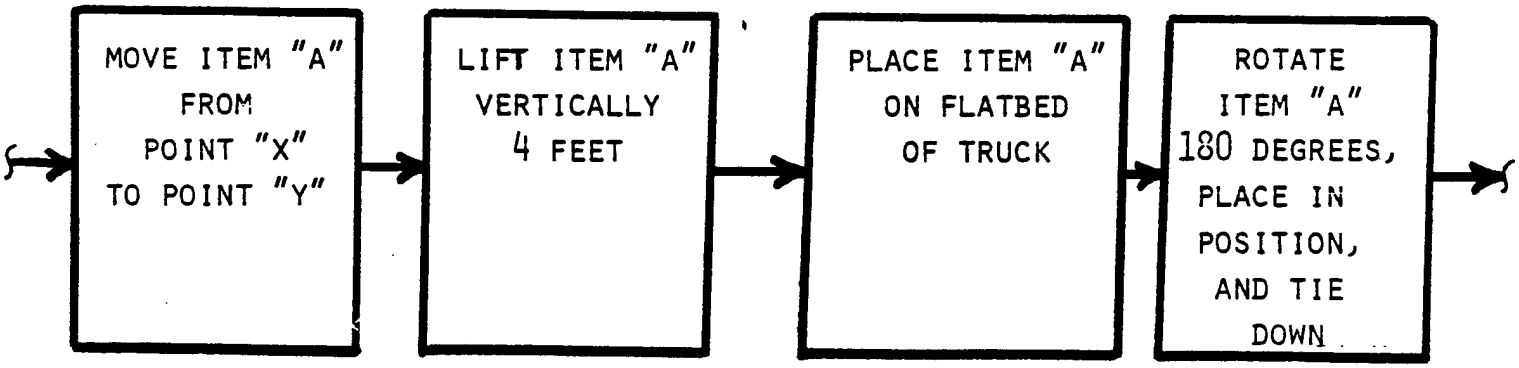
LEVEL I -- GROSS DIVISION OF ACTIVITIES



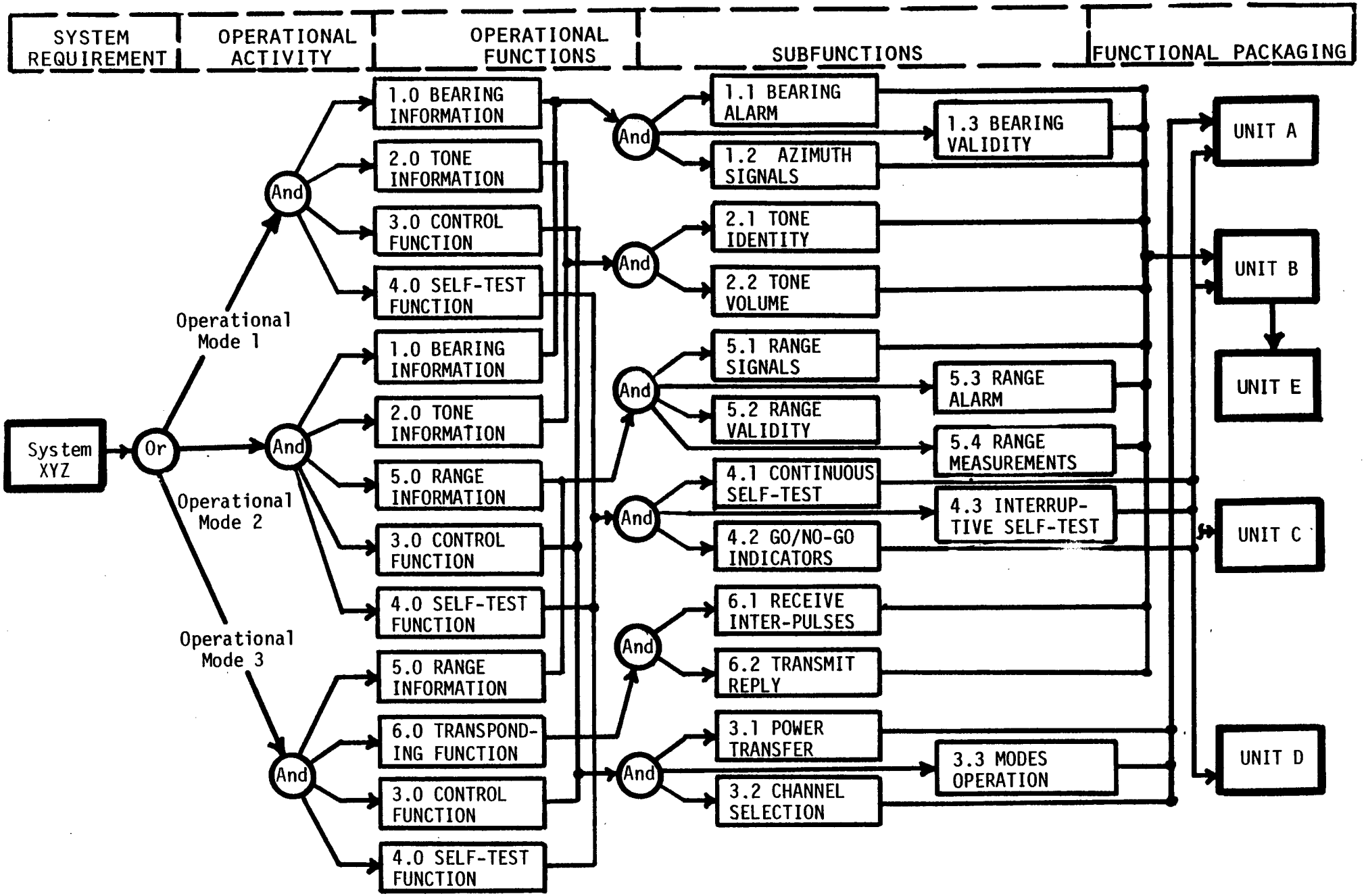
LEVEL II -- MAJOR SUBDIVISIONS



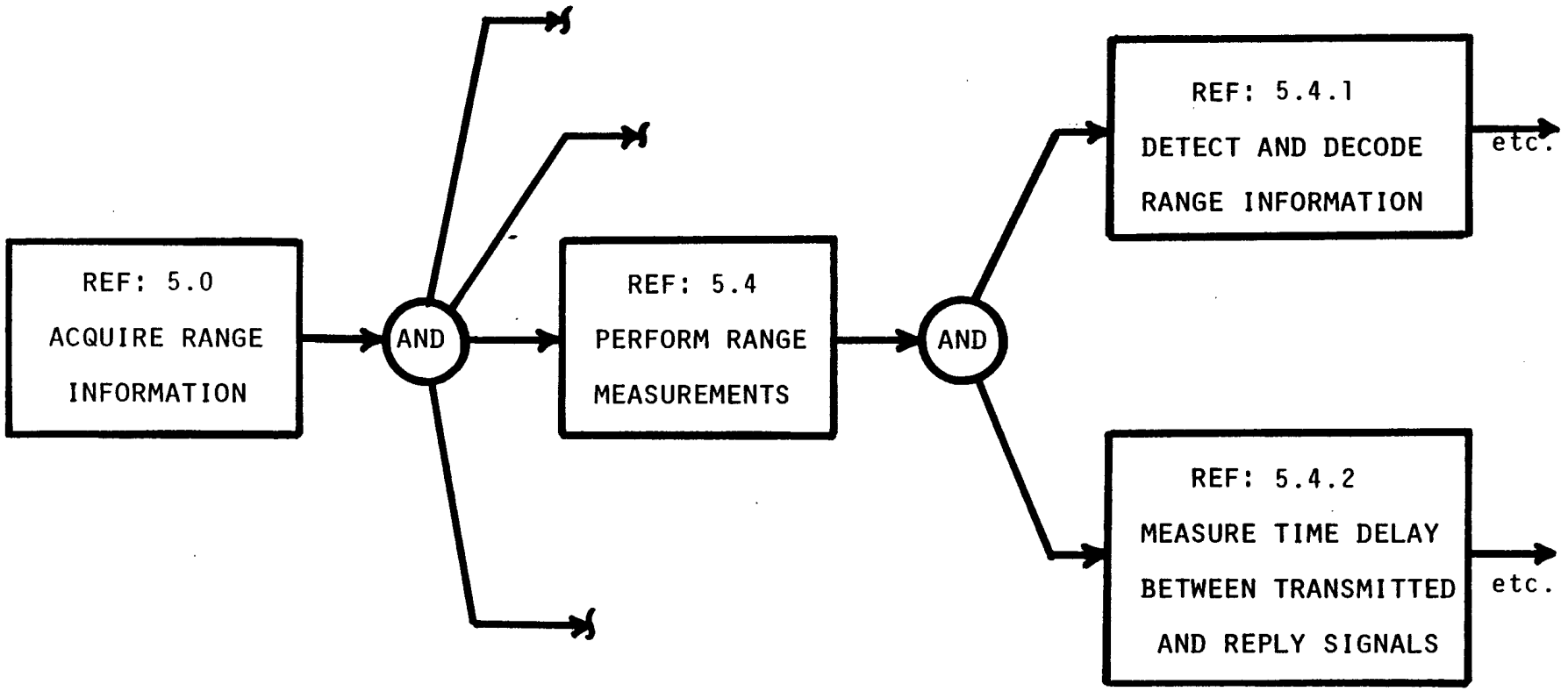
LEVEL III -- SPECIFIC PARTICLES WITH IDENTIFIABLE CHARACTERISTICS



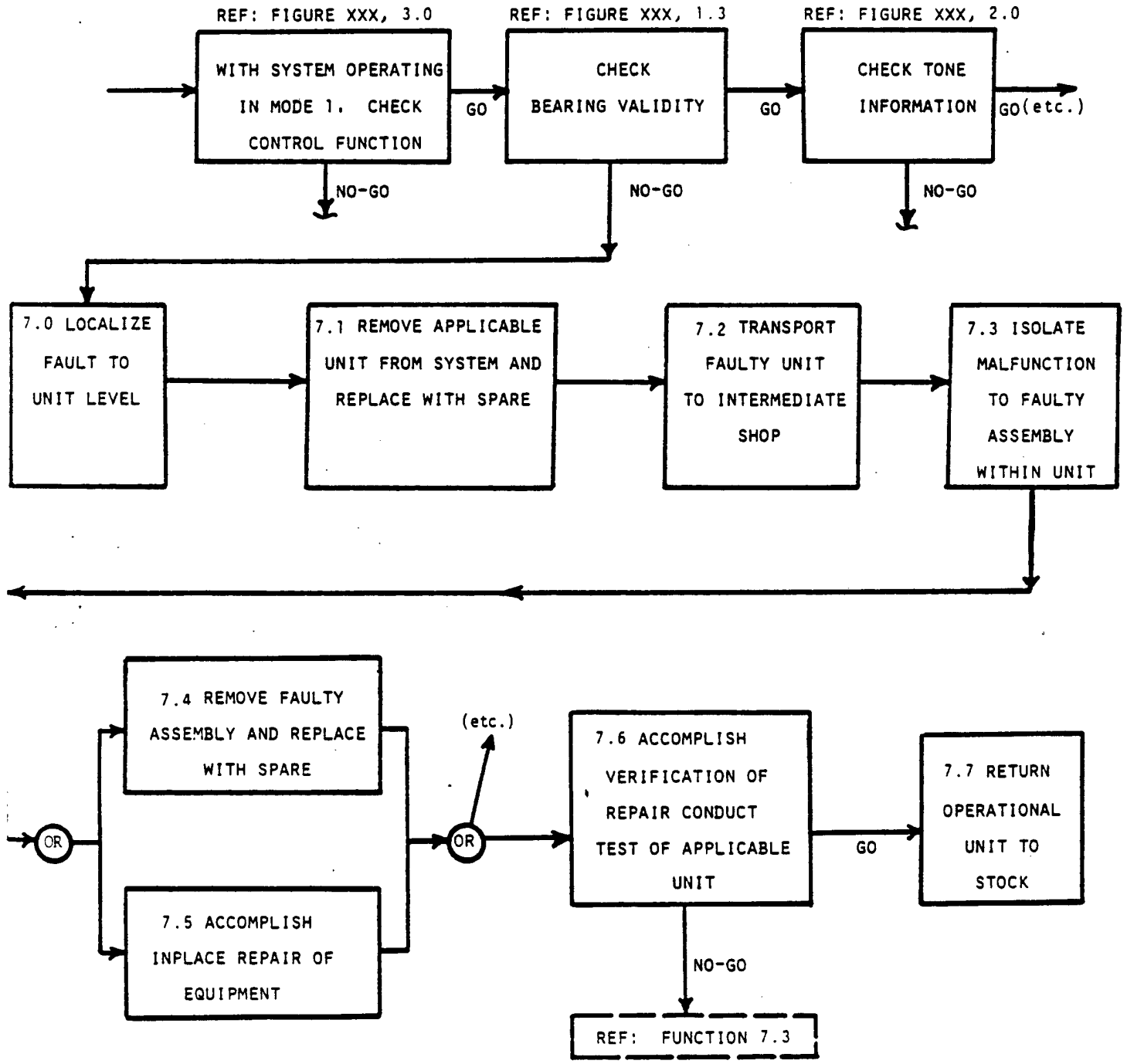
SYSTEM "XYZ" OPERATIONAL FUNCTIONAL FLOW



RANGE INFORMATION FUNCTIONAL FLOW DIAGRAM



MAINTENANCE FUNCTIONAL FLOW DIAGRAM



SYSTEM FUNCTIONAL ANALYSIS

THE FUNCTIONAL APPROACH HELPS TO ASSURE:

- THAT ALL FACETS OF SYSTEM DEVELOPMENT, OPERATION, AND SUPPORT ARE ADEQUATELY COVERED.

- THAT ALL ELEMENTS OF THE SYSTEM ARE FULLY RECOGNIZED AND DEFINED (E.G., PRIME MISSION EQUIPMENT, TEST EQUIPMENT, SOFTWARE, FACILITIES, OPERATOR PERSONNEL, ETC.)

- THAT A MEANS IS PROVIDED FOR RELATING SYSTEM/EQUIPMENT PACKAGING CONCEPTS AND SUPPORT REQUIREMENTS TO GIVEN FUNCTIONS.

- THAT THE PROPER SEQUENCES AND DESIGN RELATIONSHIPS ARE ESTABLISHED, ALONG WITH CRITICAL DESIGN INTERFACES.

FUNCTIONAL ANALYSIS IS A LOGICAL AND SYSTEMATIC APPROACH TO SYSTEM DESIGN AND DEVELOPMENT.

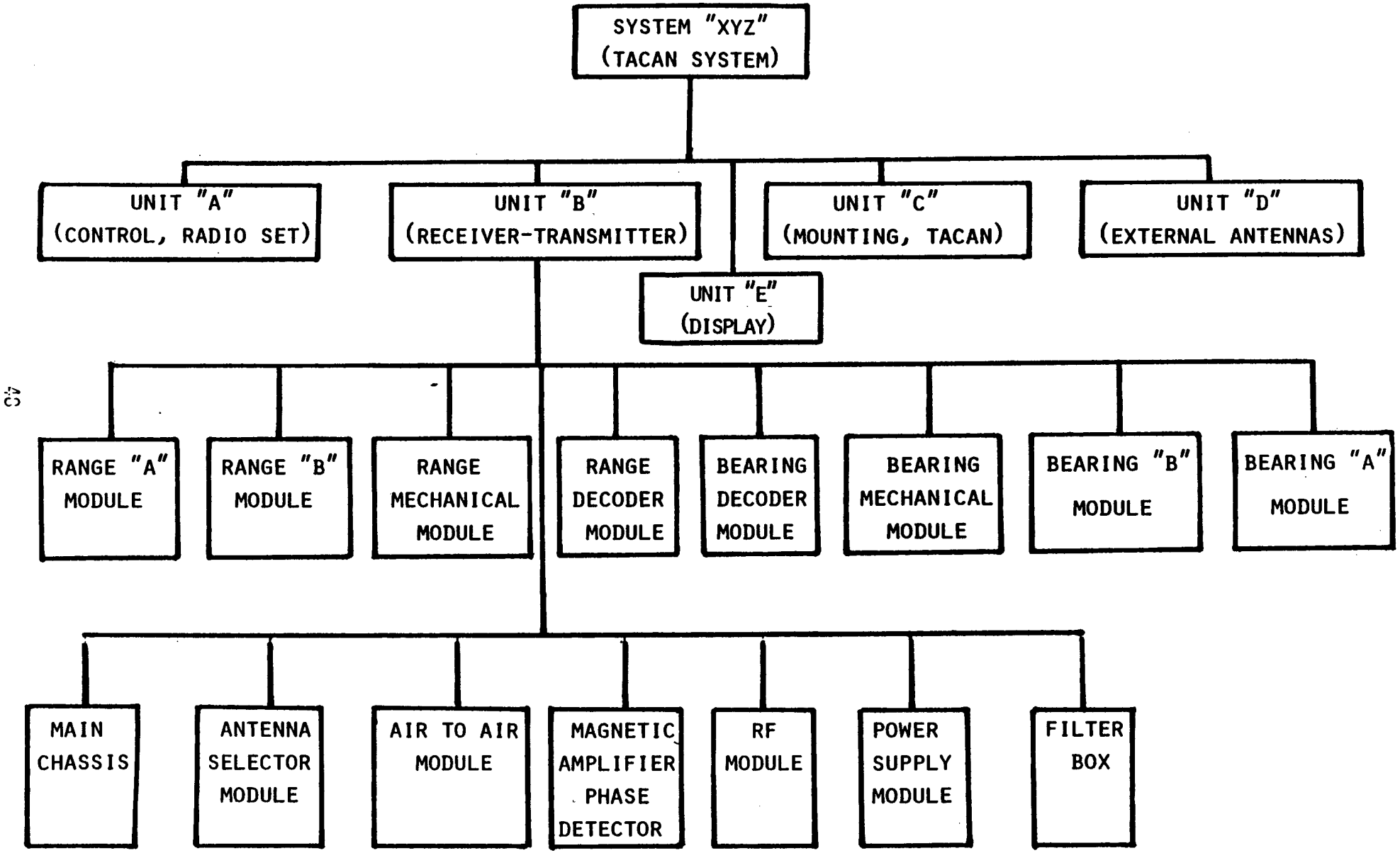
REQUIREMENTS ALLOCATION

THE DISTRIBUTION, ALLOTMENT, OR APPORTIONMENT OF TOP-LEVEL SYSTEM REQUIREMENTS TO VARIOUS ELEMENTS OF THE SYSTEM (TO THE DEPTH NECESSARY TO ENSURE CONTROL OF DESIGN)

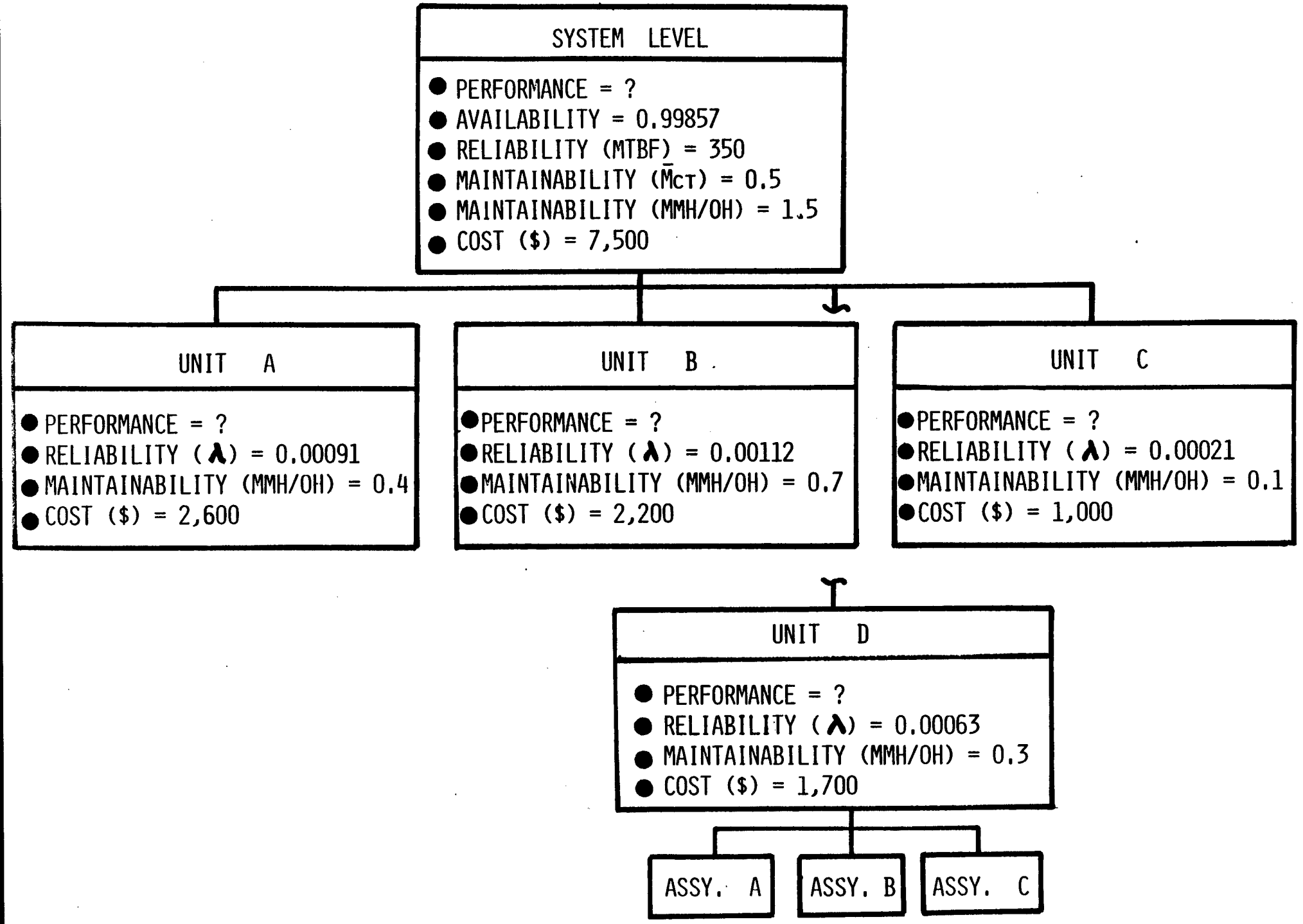
- ALLOCATION OF PERFORMANCE FACTORS
- ALLOCATION OF RELIABILITY FACTORS
- ALLOCATION OF MAINTAINABILITY FACTORS
- ALLOCATION OF LOGISTIC SUPPORT FACTORS
- ALLOCATION OF ECONOMIC FACTORS

RESULTS: QUALITATIVE AND QUANTITATIVE DESIGN CRITERIA -- AN INPUT TO SYSTEM / SUBSYSTEM SPECIFICATIONS.

SYSTEM "XYZ" EQUIPMENT BREAKDOWN



ALLOCATION OF SYST M REQUIREMENTS



ALLOCATION OF LOGISTIC SUPPORT FACTORS

- TEST EQUIPMENT UTILIZATION IN THE INTERMEDIATE MAINTENANCE SHOP SHALL BE AT LEAST 80%.
- SELF-TEST THOROUGHNESS FOR THE SYSTEM (USING THE BUILT-IN TEST CAPABILITY) SHALL BE 95% OR BETTER.
- PERSONNEL SKILL LEVELS AT THE ORGANIZATIONAL LEVEL OF MAINTENANCE SHALL BE EQUIVALENT TO GRADE X OR BELOW.
- THE MAINTENANCE FACILITY AT THE INTERMEDIATE LEVEL SHALL BE DESIGNED FOR A MINIMUM OF 75% UTILIZATION.
- THE TRANSPORTATION TIME BETWEEN THE LOCATION WHERE ORGANIZATIONAL MAINTENANCE IS ACCOMPLISHED AND THE INTERMEDIATE MAINTENANCE SHOP SHALL NOT EXCEED 48 HOURS.
- THE TURNAROUND TIME IN THE INTERMEDIATE MAINTENANCE SHOP SHALL BE 5 DAYS (OR LESS), AND 15 DAYS (OR LESS) IN THE DEPOT MAINTENANCE FACILITY.
- THE PROBABILITY OF SPARES AVAILABILITY AT THE ORGANIZATIONAL LEVEL OF MAINIENANCE SHALL BE AT LEAST 90%.

SYSTEM SYNTHESIS,

ANALYSIS AND TRADE-OFFS,

DESIGN CONSIDERATIONS,

AND

DESIGN REVIEW

S Y S T E M S Y N T H E S I S

DEFINITION:

THE PROCESS OF IDENTIFYING, DESCRIBING, COMBINING, AND STRUCTURING THE ELEMENTS OR PARTS OF A SYSTEM IN SUCH A MANNER SO AS TO FORM A FUNCTIONAL ENTITY.

NOTE: SYSTEM SYNTHESIS HAS BEEN ACHIEVED WHEN SUFFICIENT TRADE-OFFS AND PRELIMINARY DESIGN HAVE BEEN ACCOMPLISHED TO CONFIRM AND ASSURE THE COMPLETENESS OF SYSTEM PERFORMANCE AND DESIGN REQUIREMENTS ALLOCATED FOR DETAIL DESIGN.

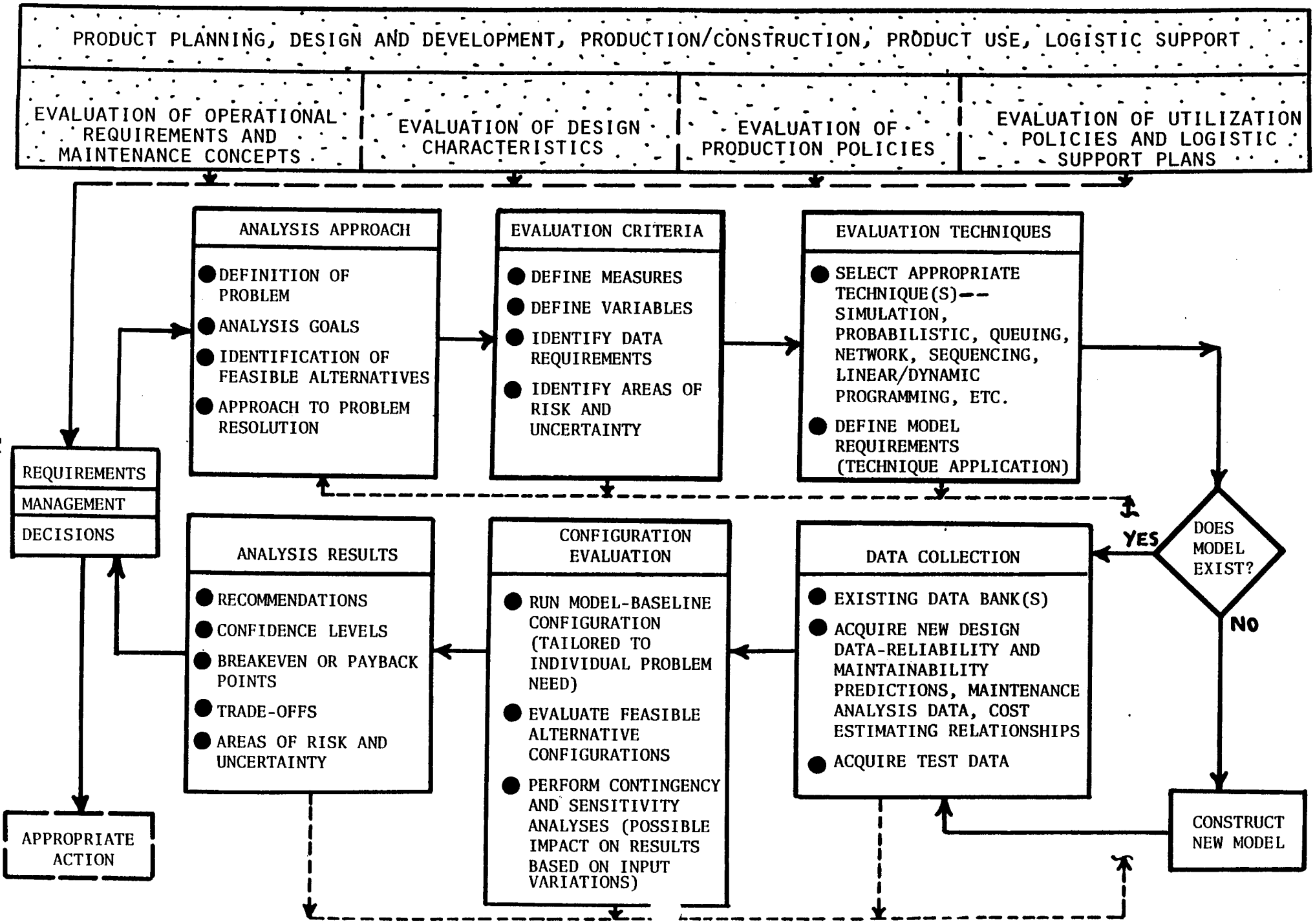
PURPOSE:

TO PROVIDE A LOGICAL AND ORGANIZED BASIS FOR THE EXAMINATION AND SELECTION OF A SYSTEM CONFIGURATION THAT MEETS ALL REQUIREMENTS IN AN EFFECTIVE AND EFFICIENT MANNER.

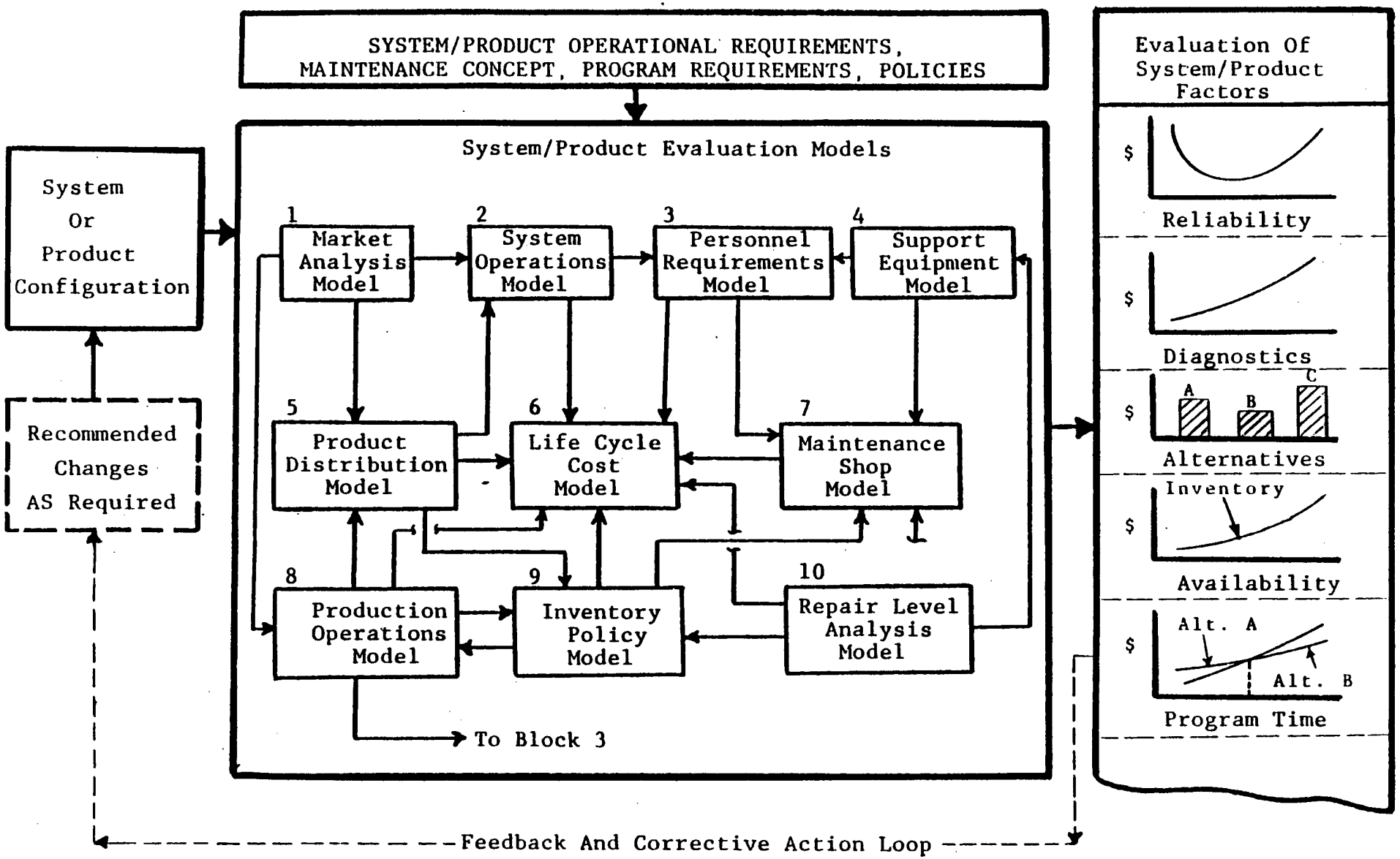
SYSTEM ANALYSIS AND TRADE-OFFS

- EVALUATION OF ALTERNATIVE OPERATING AND MAINTENANCE CONCEPTS.
- EVALUATION OF ALTERNATIVE DESIGN CONFIGURATIONS (I.E., PACKAGING SCHEMES, MAN-MACHINE FUNCTIONS, LEVELS OF DIAGNOSTICS, DEGREES OF STANDARDIZATION, RELIABILITY VERSUS MAINTAINABILITY, ETC.).
- EVALUATION OF ALTERNATIVE PROCUREMENT AND / OR PRODUCTION POLICIES.
- EVALUATION OF ALTERNATIVE UTILIZATION POLICIES AND SYSTEM SUPPORT PLANS.

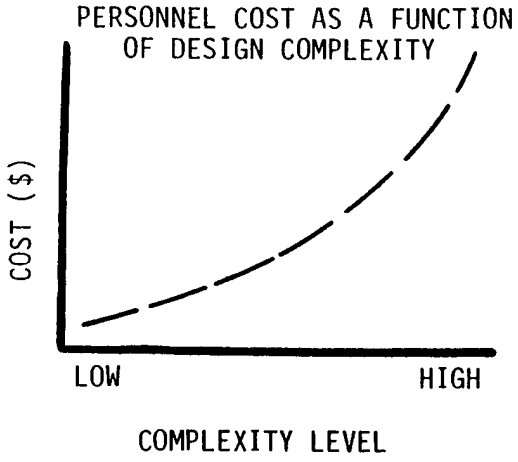
SYSTEM/PRODUCT ANALYSIS PROCESS

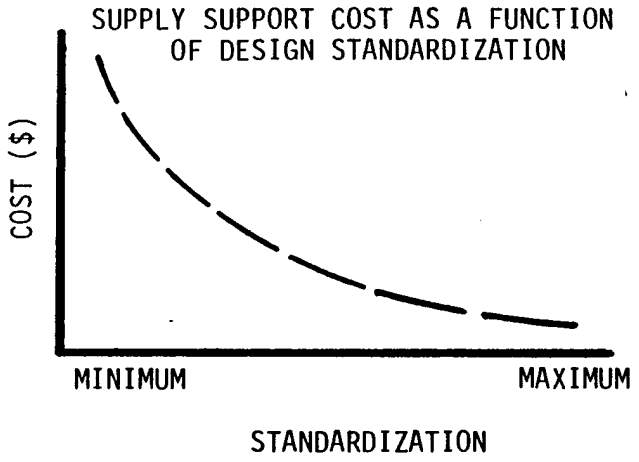


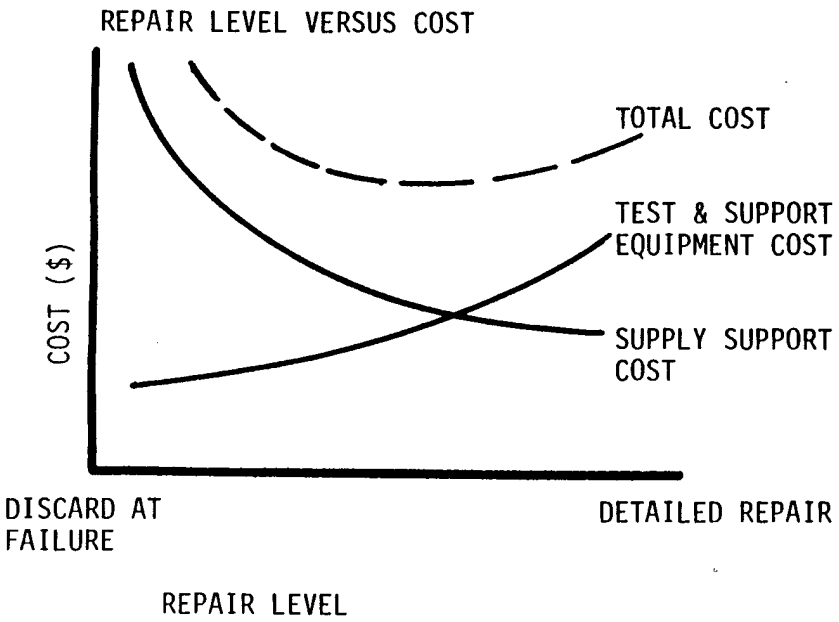
APPLICATION OF MODELS

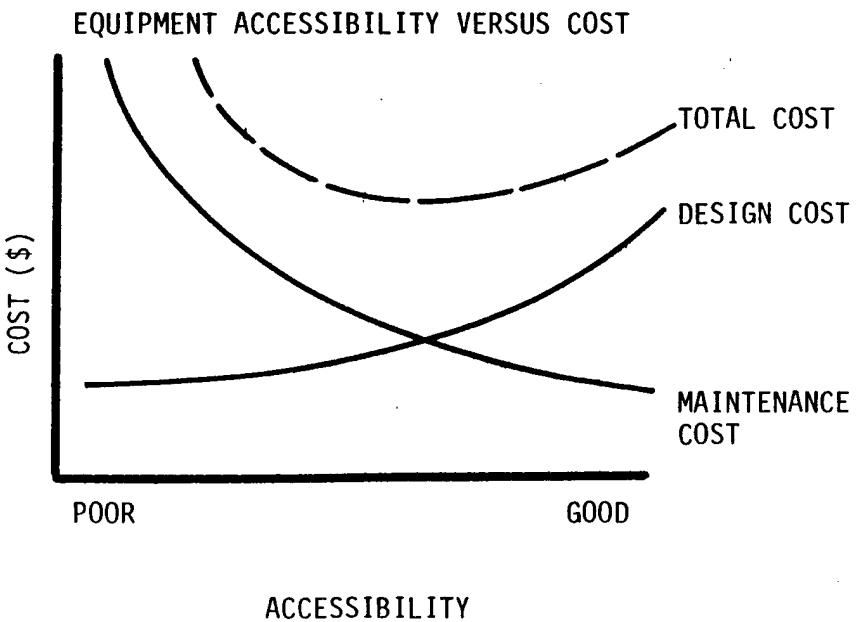


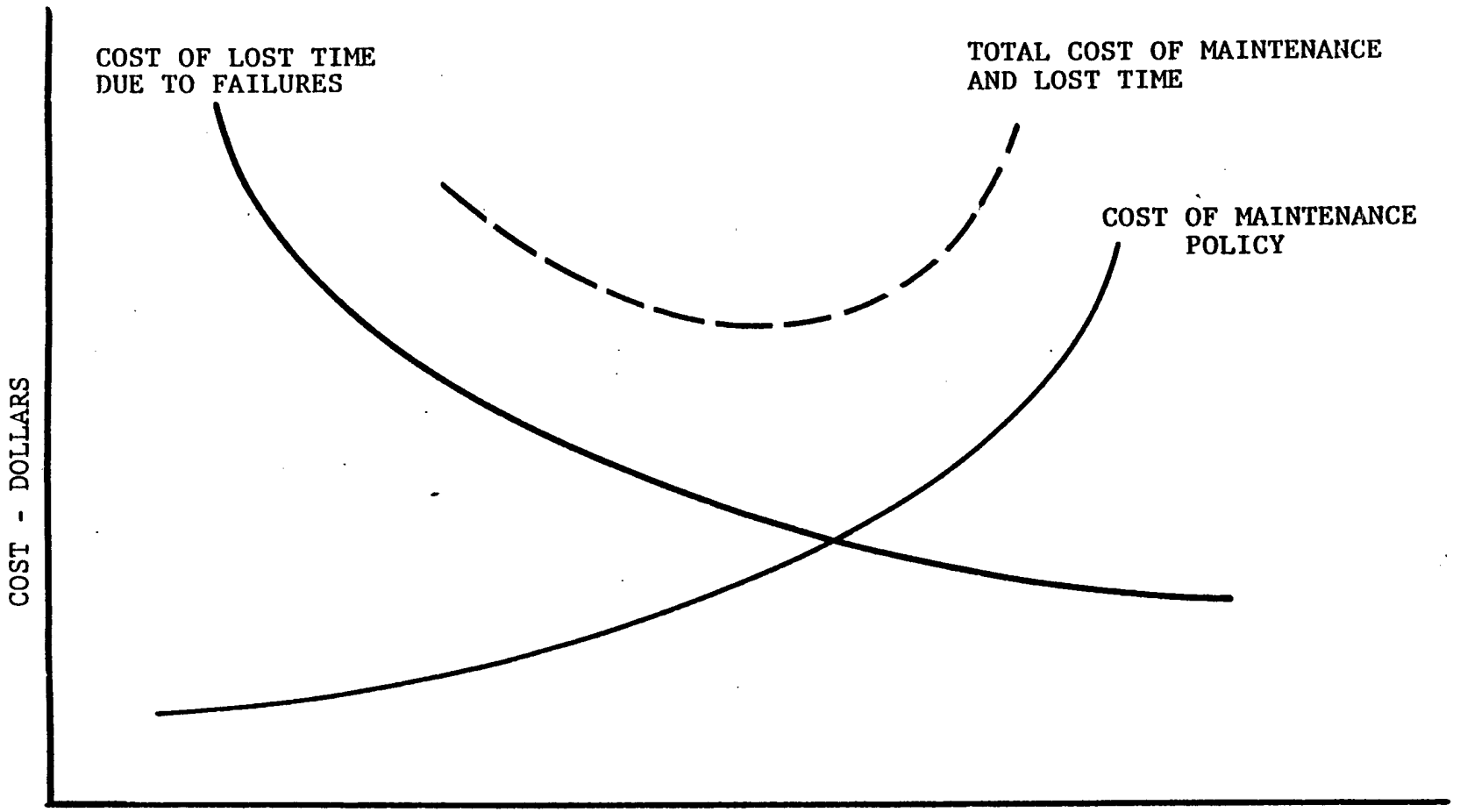
SYSTEM DESIGN VERSUS COST CONSIDERATIONS





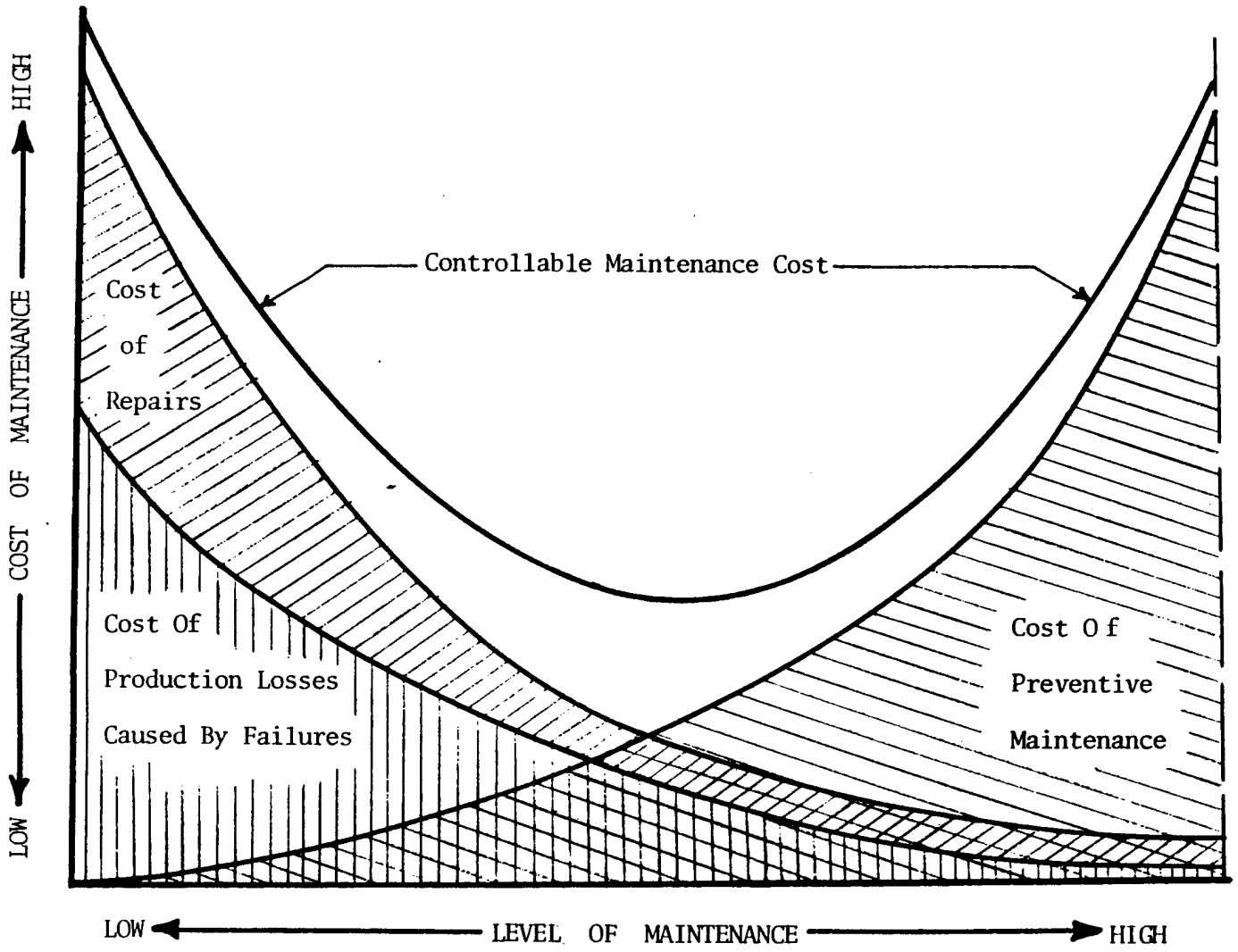




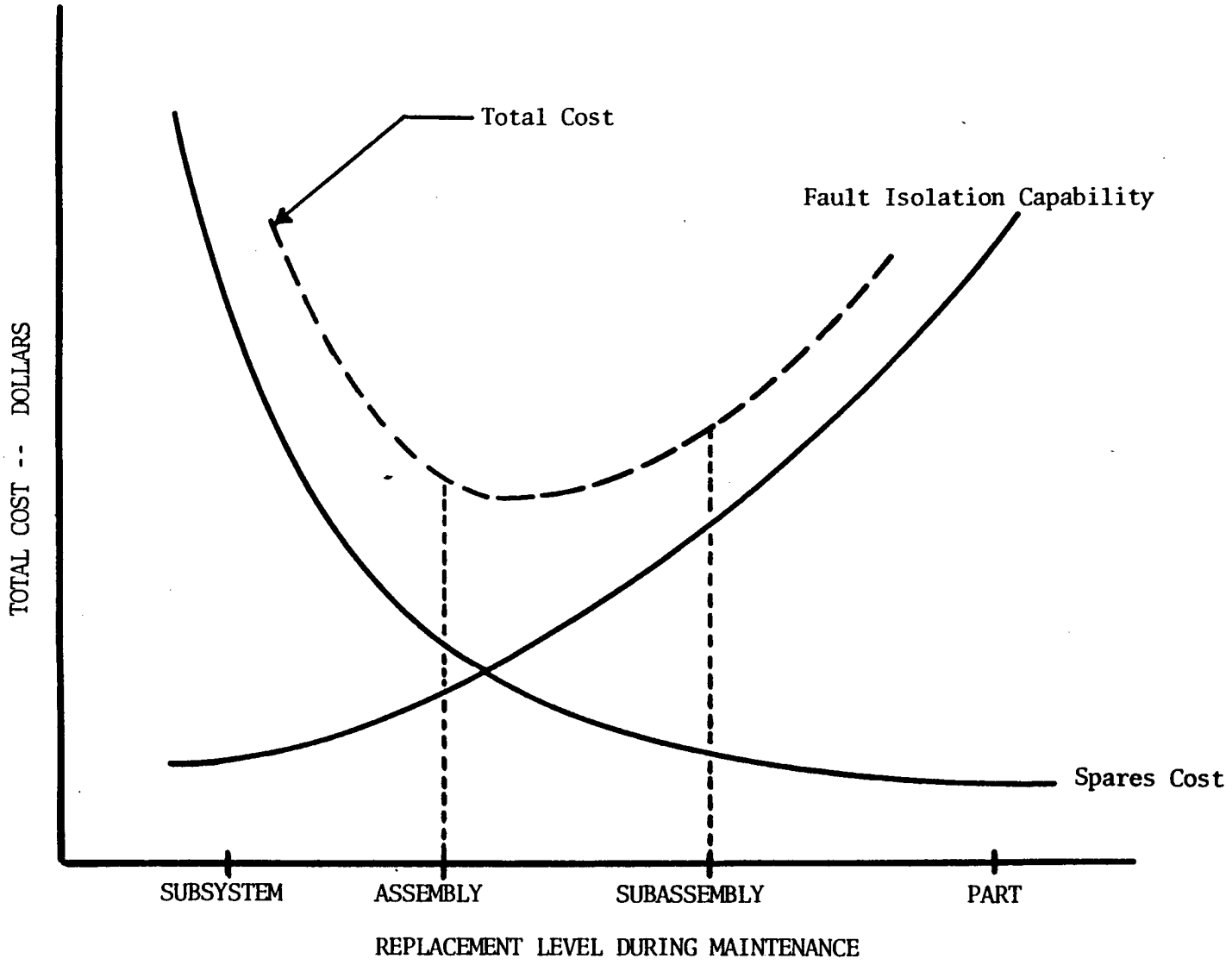


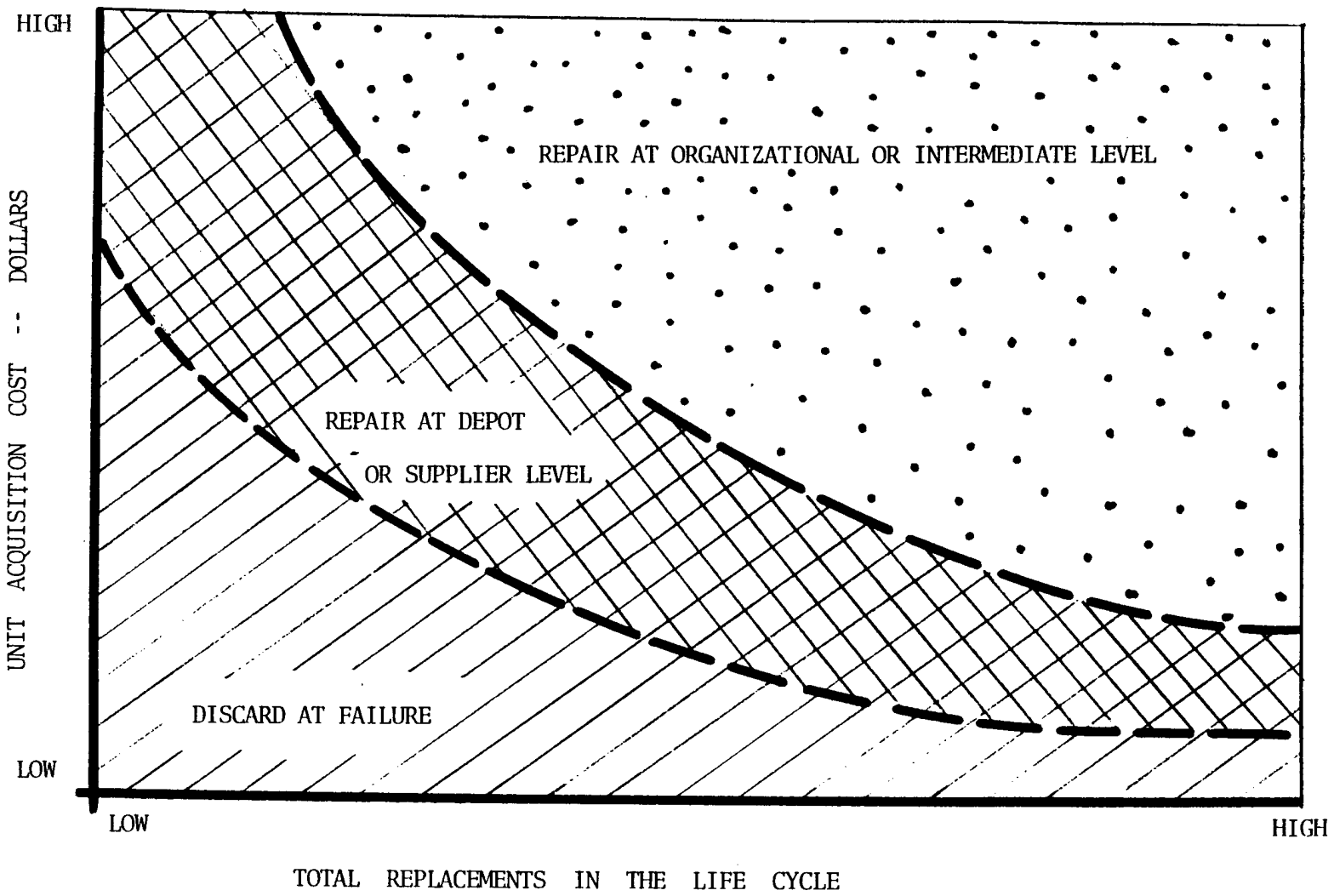
MAINTENANCE POLICY COST

CORRECTIVE — PREVENTIVE MAINTENANCE COST

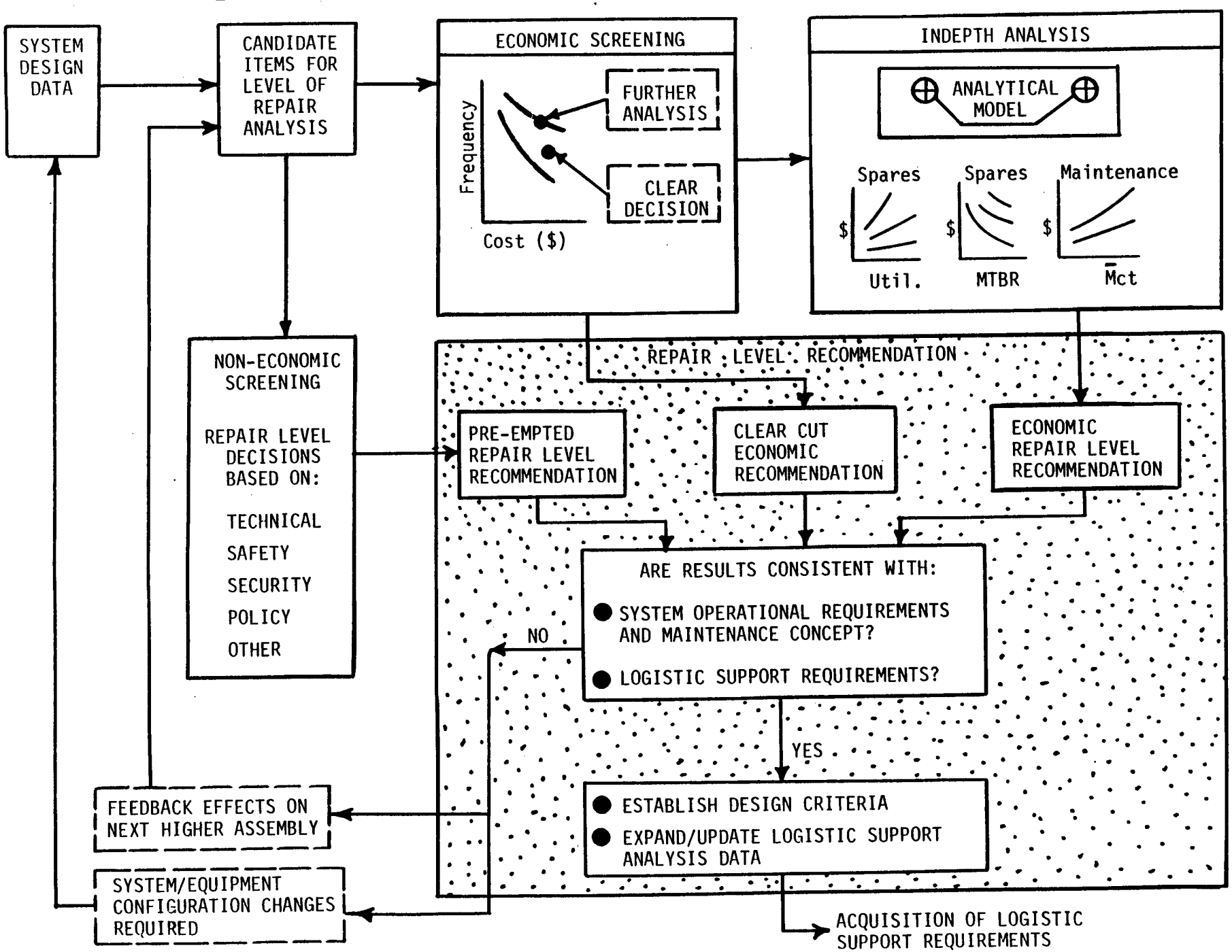


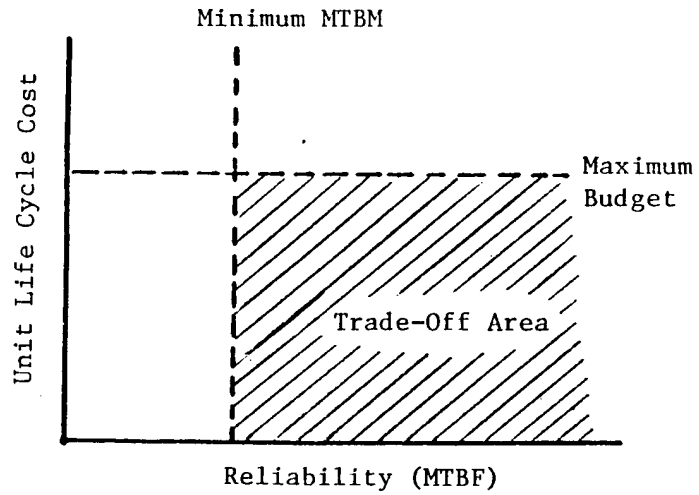
COST EFFECTIVENESS OF DIAGNOSTICS CAPABILITY

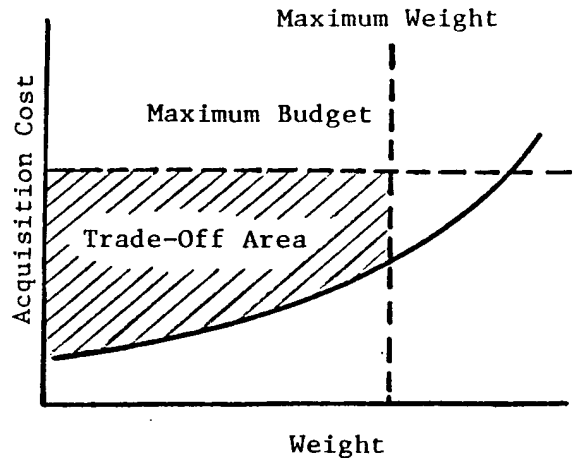


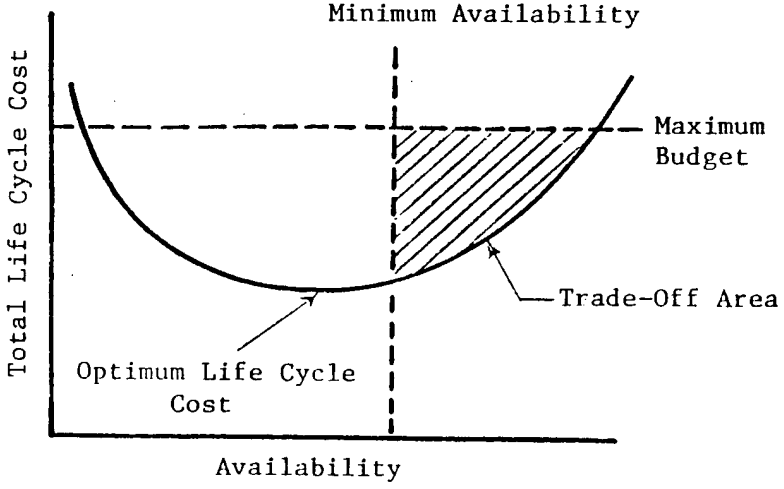

HIGH
UNIT ACQUISITION COST -- DOLLARS
LOW
REPAIR AT ORGANIZATIONAL OR INTERMEDIATE LEVEL
REPAIR AT DEPOT
OR SUPPLIER LEVEL
DISCARD AT FAILURE
LOW
HIGH
TOTAL REPLACEMENTS IN THE LIFE CYCLE

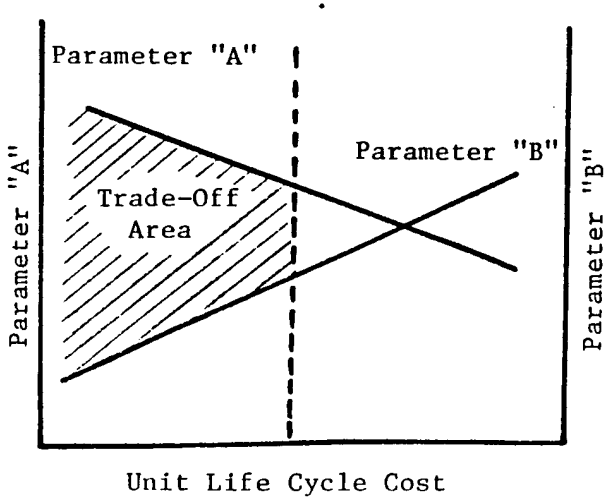
LEVEL OF REPAIR ANALYSIS PROCESS





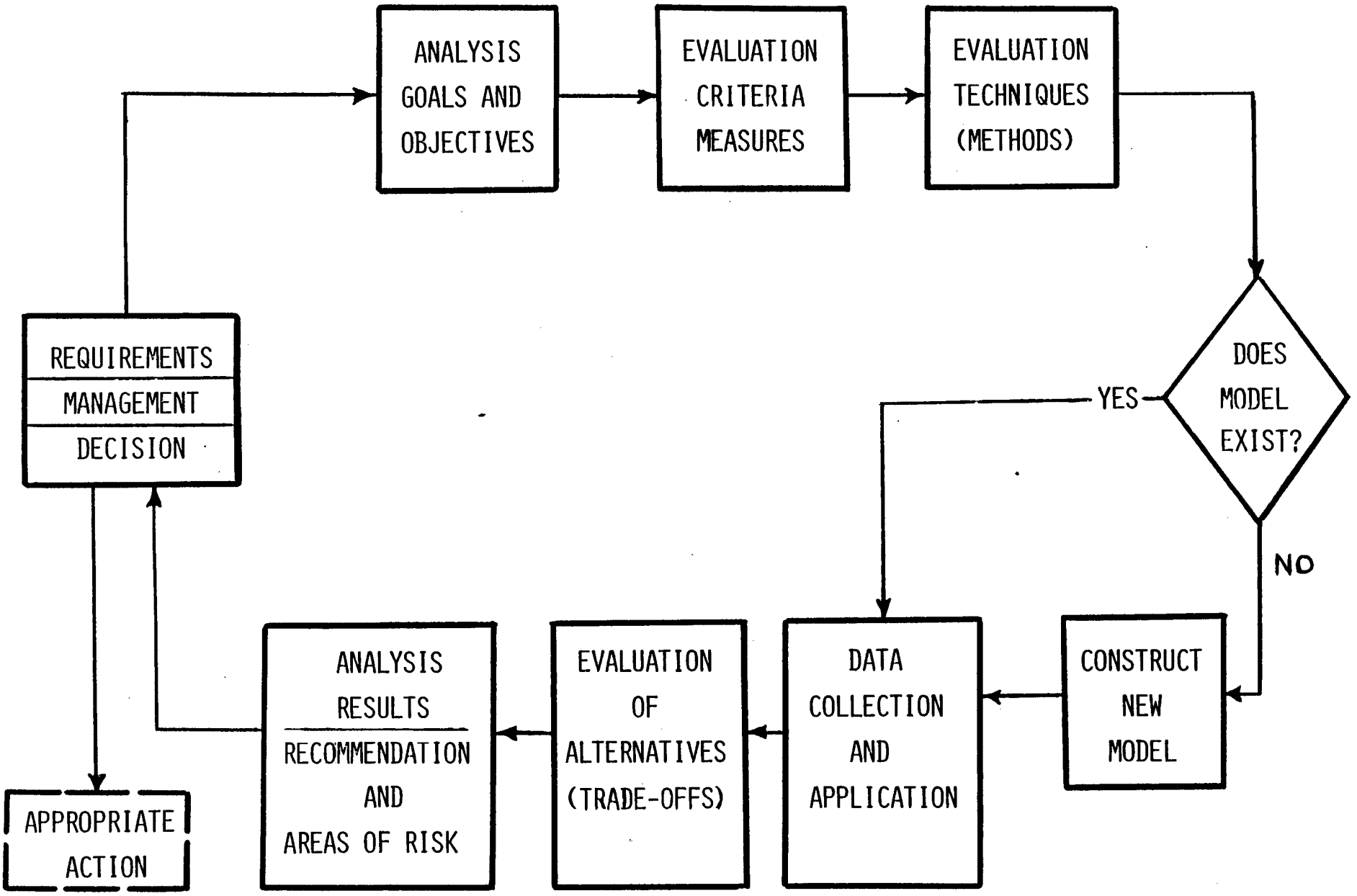






Trade-Off Areas (Showing Bounds)

SYSTEM/PRODUCT ANALYSIS PROCESS



DESIGN CONSIDERATIONS

- SYSTEM/EQUIPMENT DESIGN FEATURES

  a. Accessibility

  b. Functional packaging - modularization, interchangeability, optimum design for discard-at-failure

  c. Standardization - selection of components

  d. Rapid and positive test (built-in test equipment/external test equipment)

  e. Mobility (transportation and handling)

  f. Adequate panel displays, controls and labeling

  g. Minimum design complexity

  h. Safety of personnel and equipment

  i. Producibility

- SYSTEM SUPPORT

  THE COMPATIBILITY OF THE LOGISTIC SUPPORT SUBSYSTEM WITH PRIME EQUIPMENT DESIGN, SOFTWARE, ETC., THROUGH DETERMINATION OF THE PROPER TYPE AND QUANTITY OF SUPPORT.

- SPARE/REPAIR PARTS

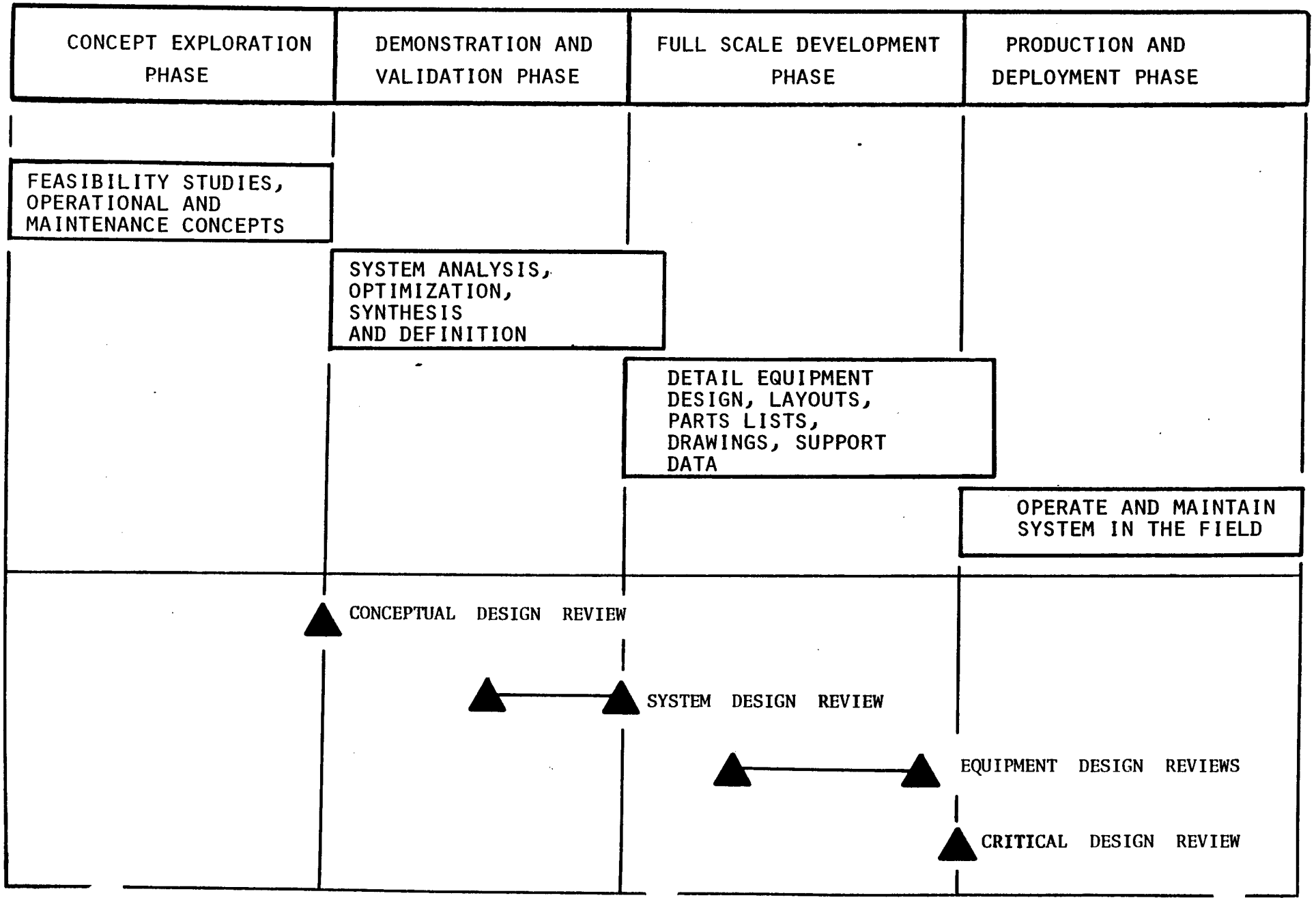
  a. Type of spares--functional packaging, modularization, mounting, diagnostic aids (depth and thoroughness of test), standardization, interaction effects.

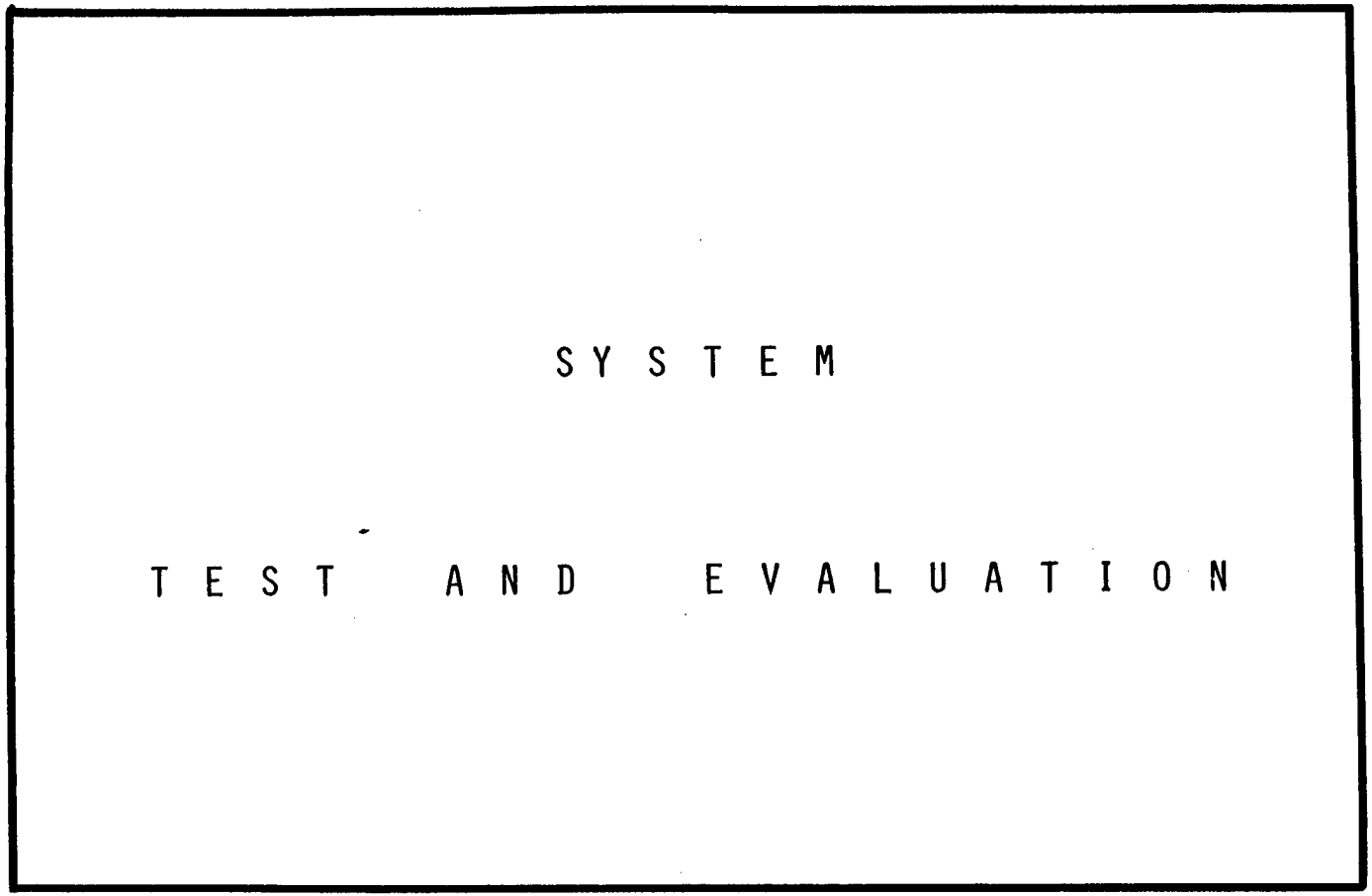
  b. Quantity of spares--scheduled replacements (critical items, shelf life, overhaul, calibration), unscheduled replacements (primary failures/MTBF, dependent failures, quality defects, suspected failures, operator and maintenance induced failures).

DESIGN CONSIDERATIONS

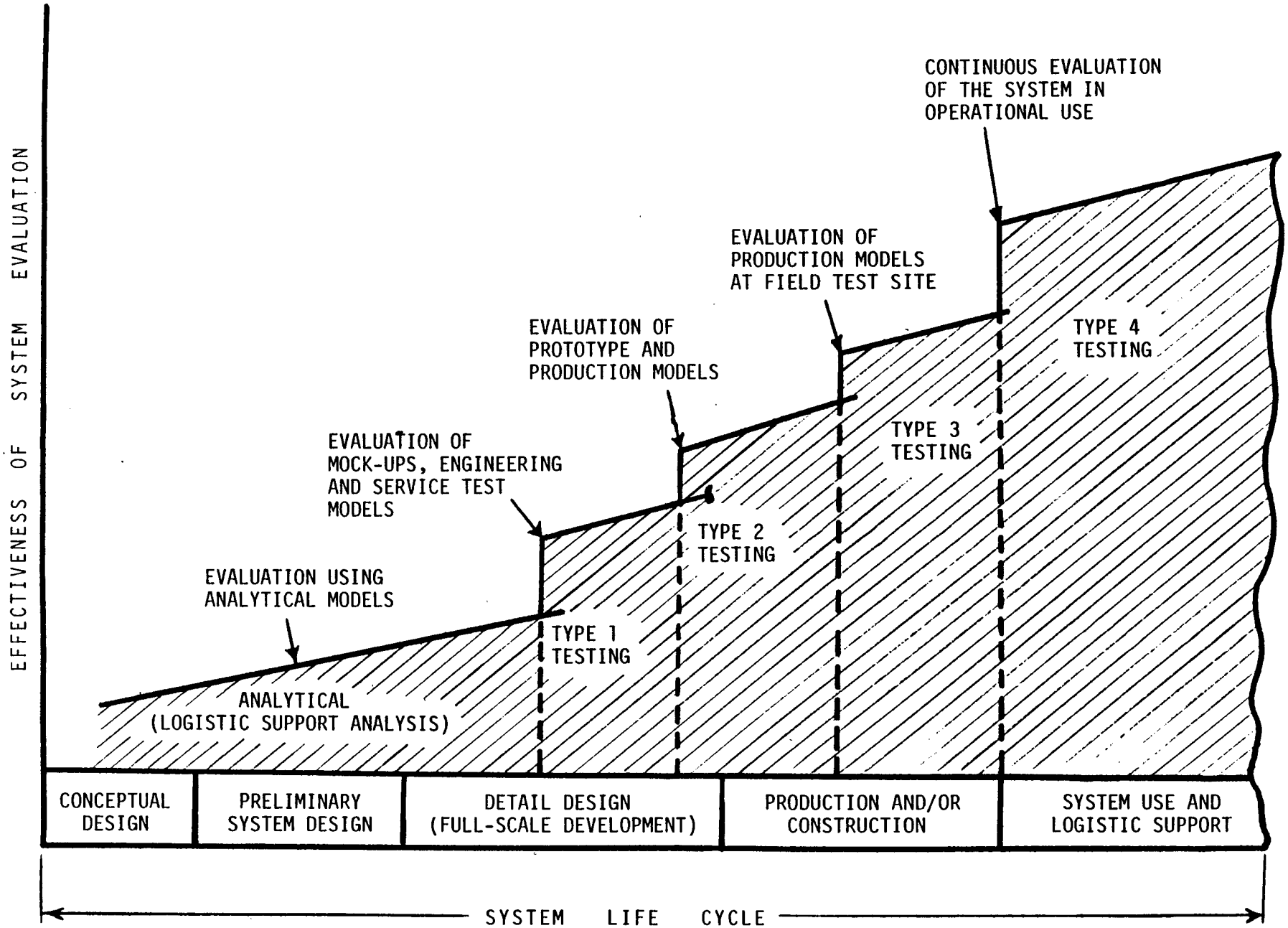
- SUPPORT EQUIPMENT REQUIREMENTS - DEPENDENT ON:
  a. Parameters-operational modes tested, critical parameters, FMEA.
  b. Depth of testing-related to functional packaging, modularization, placement of test points.
  c. Frequency of testing-indicated by MTB factor.
  d. Duration of testing-based on MDT requirements, use of automatic versus manual test, built-in versus external test.
  e. Environmental conditions.
- PERSONNEL AND TRAINING REQUIREMENTS - BASED ON:
  a. Operator and maintenance tasks-task duration, scheduling, and complexity.
  b. Training-personnel needs versus available personnel.
  c. Training equipment and data.
- FACILITY REQUIREMENTS - BASED ON:
  a. Maintenance tasks (dexterity required for task accomplishment, accuracy of testing/calibration, repetition of testing, variety of testing).
  b. Personnel safety (size and weight of test item, other hazards).
  c. Storage requirements (inventory requirements).
- FACILITIES SHOULD PROVIDE PROPER ENVIRONMENTAL CONDITIONS (ILLUMINATION, NOISE LEVEL, TEMPERATURE AND HUMIDITY, CLEAN ATMOSPHERE, ETC.)
- TECHNICAL DATA - SCOPE AND CONTENT

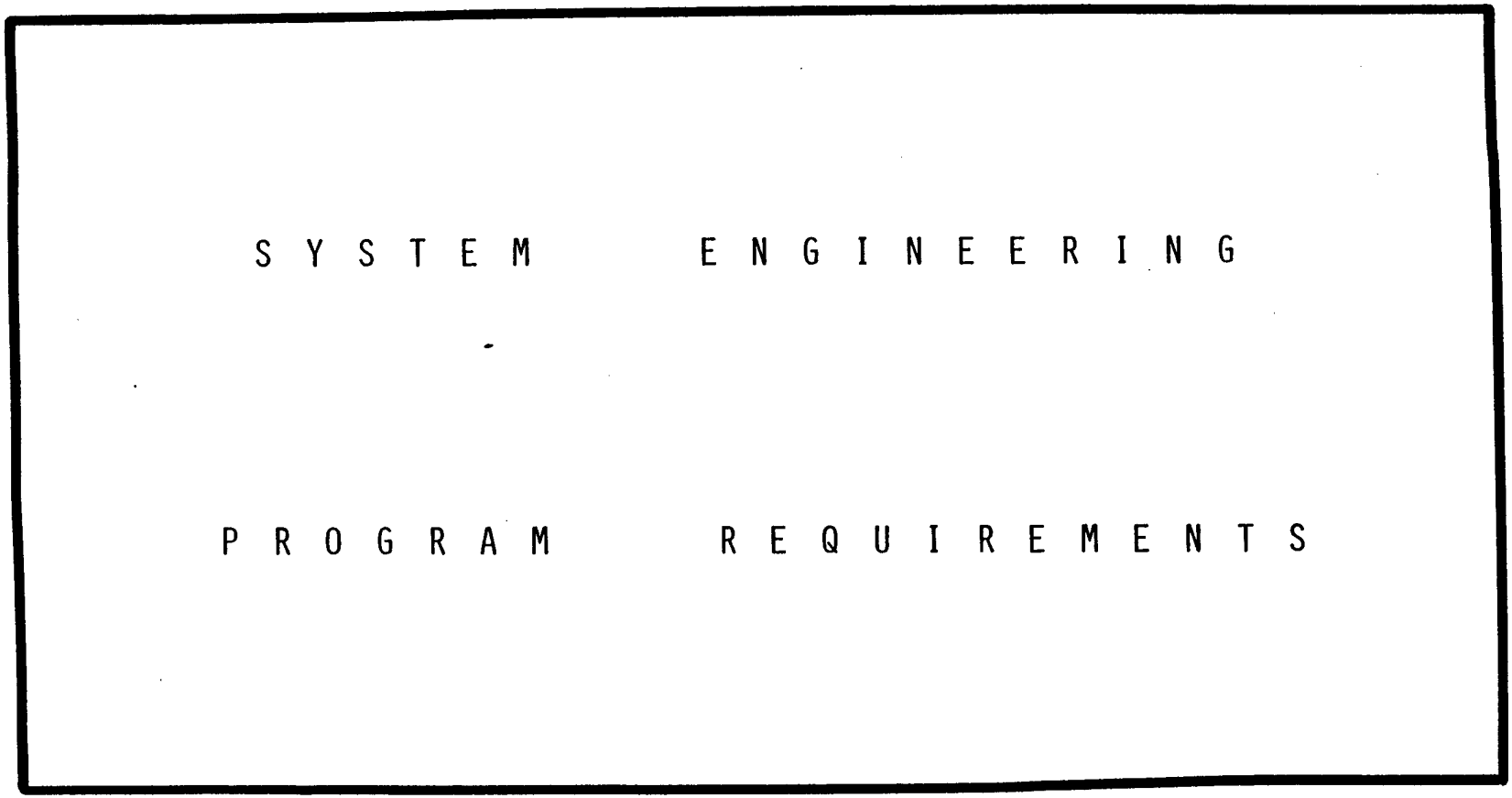
DESIGN REVIEW SCHEDULE IN RELATIONSHIP TO PROGRAM PHASES



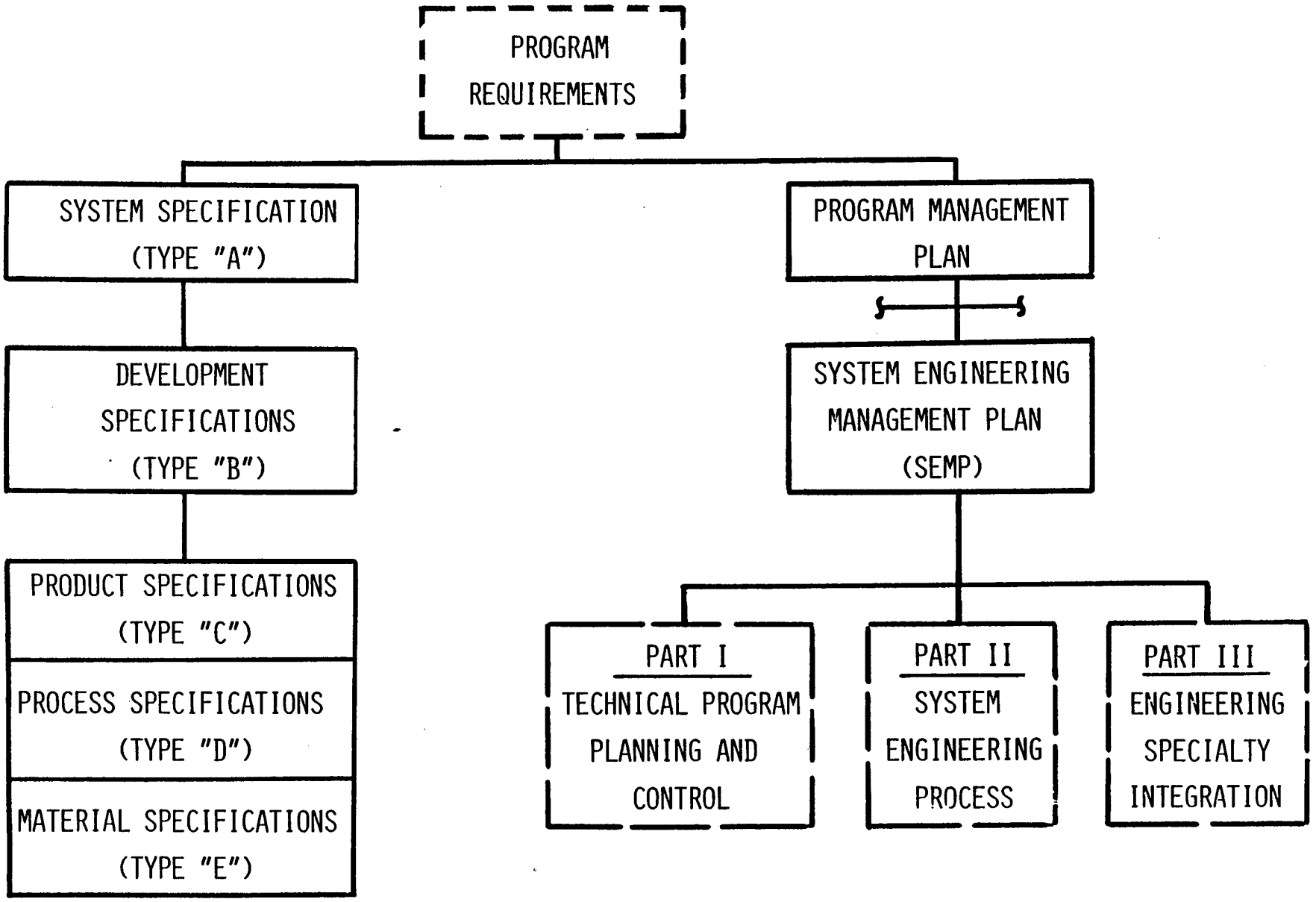

SYSTEM
TEST AND EVALUATION

STAGES OF SYSTEM EVALUATION DURING THE LIFE CYCLE

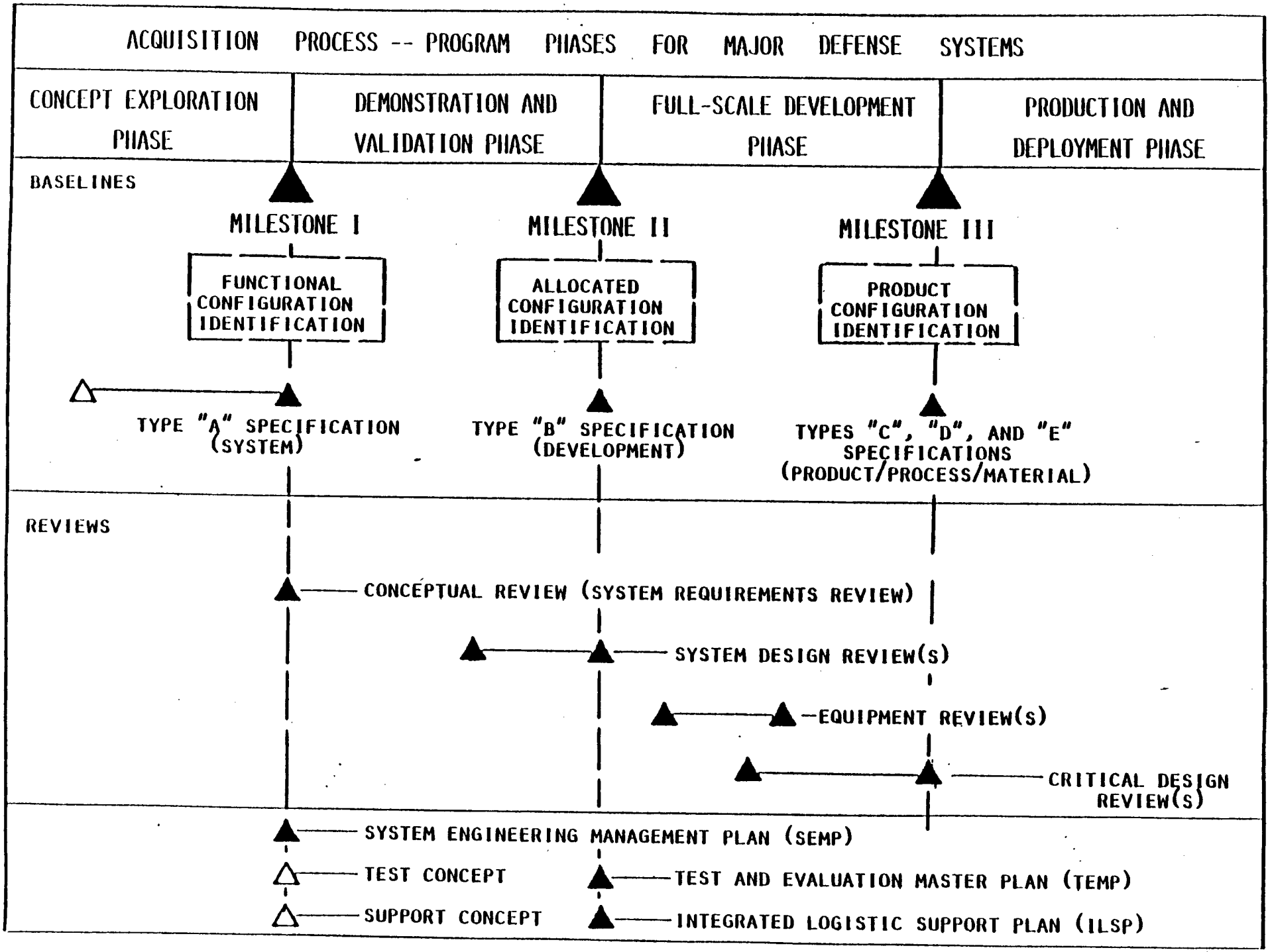



S Y S T E M E N G I N E E R I N G
P R O G R A M R E Q U I R E M E N T S

PROGRAM DOCUMENTATION REQUIREMENTS



ACQUISITION PROCESS



TYPES OF SPECIFICATIONS AND APPLICATIONS

SPECIFICATION TYPES	SPECIFICATION TITLE/APPLICATION	DESCRIPTION OF SPECIFICATION CONTENT
TYPE "A"	SYSTEM SPECIFICATION	TECHNICAL AND MISSION REQUIREMENTS FOR SYSTEM; ALLOCATIED REQUIREMENTS FOR FUNCTIONAL AREAS; DEFINITION OF INTERFACES BETWEEN/AMONG FUNCTIONAL AREAS, (MAINTAINED THROUGHOUT CONCEPT EXPLORATION PHASE).
TYPE "B" TYPE "B1" TYPE "B2" TYPE "B3" TYPE "B4" TYPE "B5"	DEVELOPMENT SPECIFICATION PRIME ITEM DEVP. CRITICAL ITEM DEVP. NON-COMPLEX ITEM DEVP. FACILITY OR SHIP DEVP. COMPUTER PROGRAM DEVP.	REQUIREMENTS FOR ENGINEERING DEVELOPMENT AND DESIGN OF A PRODUCT; DETAILED PERFORMANCE CHARACTERISTICS; PHYSICAL CHARACTERISTICS; RELIABILITY AND MAINTAINABILITY REQUIREMENTS; SAFETY AND HUMAN ENGINEERING REQUIREMENTS; LOGISTICS AND QUALITY ASSURANCE REQUIREMENTS; AND SO ON.
TYPE "C" TYPE "C1" TYPE "C2" TYPE "C3" TYPE "C4" TYPE "C5"	PRODUCT SPECIFICATION PRIME ITEM PRODUCT CRITICAL ITEM PRODUCT NON-COMPLEX ITEM PRODUCT INVENTORY ITEM COMPUTER PROGRAM PRODUCT	APPLICABLE TO ANY ITEM BELOW SYSTEM LEVEL, AND MAY BE ORIENTED TOWARD PROCUREMENT OF A PROUDCT THROUGH SPECIFICATION OF PRIMARY FUNCTION (PERFORMANCE) REQUIRMENTS OR PRIMARY FABRICATION (DETAILED DESIGN) REQUIREMENTS.
TYPE "D"	PROCESS SPECIFICATION	APPLICABLE TO A SERVICE WHICH IS PERFORMED ON A PRODUCT OR MATERIAL.
TYPE "E"	MATERIAL SPECIFICATION	APPLICABLE TO A RAW MATERIAL, MEXTURES, OR SEMI-FABRICATED MATERIAL WHICH ARE USED IN THE FABRICATION OF A PRODUCT.

REFERENCE: MIL-STD-490, MILITARY STANDARD, SPECIFICATION PRACTICES.

TYPE "A" -- SYSTEM SPECIFICATION (MIL-STD-490)

1.0 SCOPE

2.0 APPLICABLE DOCUMENTS

3.0 REQUIREMENTS

- 3.1 SYSTEM DEFINITION
- 3.1.1 GENERAL DESCRIPTION
- 3.1.2 MISSIONS
- 3.1.3 THREAT
- 3.1.5 SYSTEM DIAGRAMS
- 3.1.5 INTERFACE DEFINITIONS
- 3.1.6 GOVERNMENT FURNISHED PROPERTY LIST
- 3.1.7 OPERATION AND ORGANIZATIONAL CONCEPTS
- 3.2 CHARACTERISTICS
- 3.2.1 PERFORMANCE CHARACTERISTICS
- 3.2.2. PHYSICAL CHARACTERISTICS
- 3.2.3 RELIABILITY
- 3.2.4 MAINTAINABILITY
- 3.2.5 AVAILABILITY
- 3.2.6 SYSTEM EFFECTIVENESS
- 3.2.7 ENVIRONMENTAL CONDITIONS
- 3.2.8 NUCLEAR CONTROL REQUIREMENTS
- 3.2.9 TRANSPORTABILITY
- 3.3 DESIGN AND CONSTRUCTION
- 3.3.1 MATERIALS, PROCESSES, AND PARTS
- 3.3.2 ELECTROMAGNETIC RADIATION
- 3.3.3 NAMEPLATES AND PRODUCT MARKING
- 3.3.4 WORKMANSHIP
- 3.3.5 INTERCHANGEABILITY
- 3.3.6 SAFETY
- 3.3.7 HUMAN PERFORMANCE/HUMAN ENGINEERING
- 3.4 DOCUMENTATION
- 3.5 LOGISTICS
- 3.5.1 MAINTENANCE
- 3.5.2 SUPPLY
- 3.5.3 FACILITIES AND FACILITY EQUIPMENT
- 3.6 PERSONNEL AND TRAINING
- 3.6.1 PERSONNEL
- 3.6.2 TRAINING
- 3.7 FUNCTIONAL AREA CHARACTERISTICS
- 3.8 PRECEDENCE

4.0 QUALITY ASSURANCE PROVISIONS

5.0 PREPARATION FOR DELIVERY

SYSTEM ENGINEERING MANAGEMENT PLAN (SEMP)

PART I - TECHNICAL PROGRAM PLANNING

DESCRIBES THE TECHNICAL PROGRAM TASKS THAT MUST BE PLANNED AND DEVELOPED USING CONCEPTS AND THE ITERATIVE PROCESS EMPLOYED IN SYSTEM DEFINITION

INCLUDES:

- STATEMENT OF WORK - WORK BREAKDOWN STRUCTURE (WBS)
- SCHEDULING
- ORGANIZATION
- TECHNICAL PERFORMANCE MEASUREMENT (TPM)
- PROGRAM/DESIGN REVIEWS
- PROGRAM INTERFACES
- SUPPLIER/SUBCONTRACTOR REQUIREMENTS
- RISK ANALYSIS

PART II - SYSTEM ENGINEERING PROCESS

DESCRIBES THE SYSTEM ENGINEERING PROCESS AS IT APPLIED TO THE DEFINITION OF SYSTEM DESIGN, TEST AND SUPPORT REQUIREMENTS DURING THE CONTRACTUAL PROGRAM EFFORT

INCLUDES:

- SYSTEM OPERATIONAL REQUIREMENTS AND MAINTENANCE CONCEPT
- FUNCTIONAL ANALYSIS
- REQUIREMENTS ALLOCATION
- SYSTEM SYNTHESIS
- SYSTEM ANALYSIS AND TRADE-OFFS
- SYSTEM DESIGN
- SYSTEM TEST AND EVALUATION

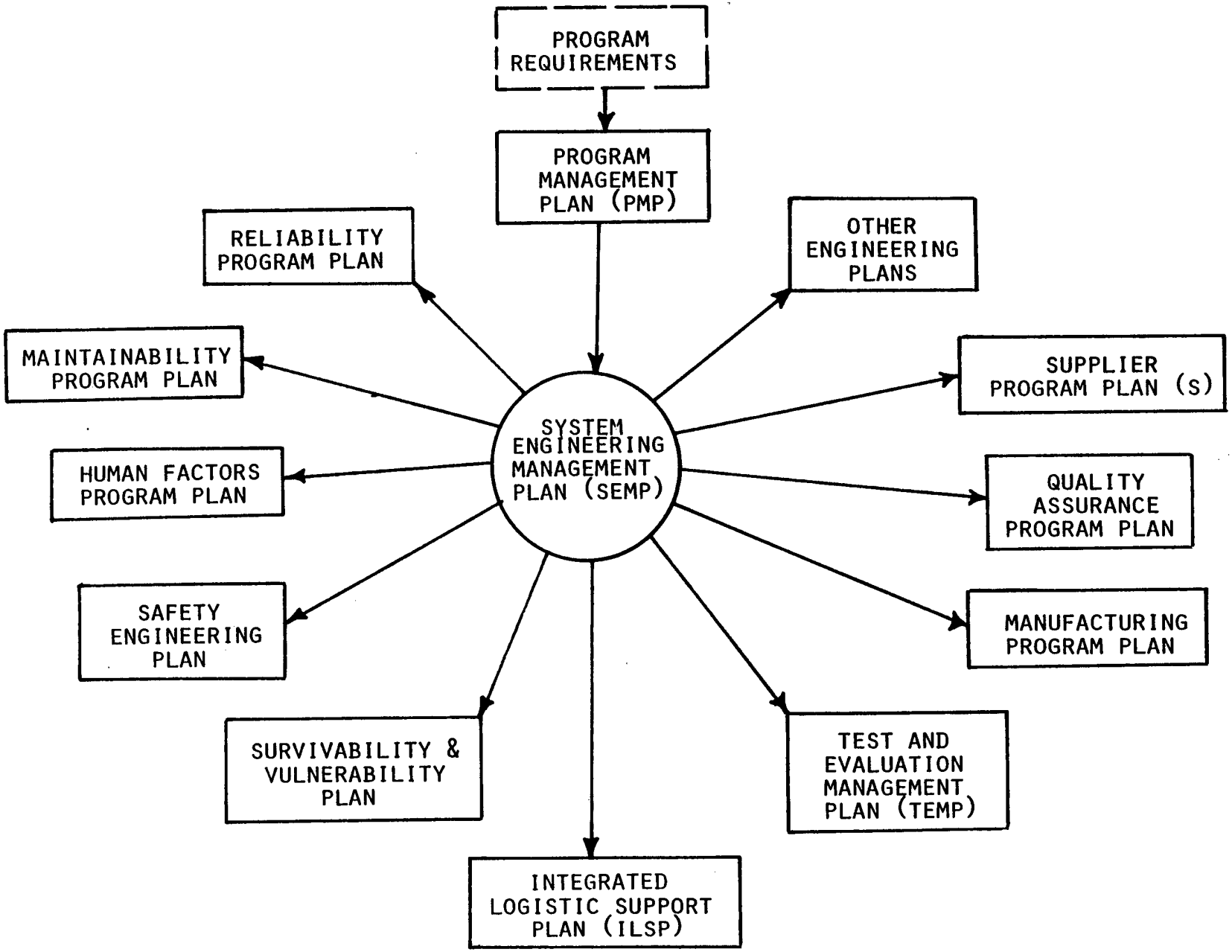
PART III - ENGINEERING SPECIALTY INTEGRATION

DESCRIBES THE SYSTEM REQUIREMENTS IN ENGINEERING SPECIALTY AREAS, AND THE INTEGRATION OF THESE SPECIALTY AREAS INTO THE OVERALL ENGINEERING DEVELOPMENT PROCESS

INCLUDES:

- RELIABILITY (MIL-STD-785, MIL-STD-721, MIL-STD-756, MIL-STD-781, MIL-STD-1629,
- MAINTAINABILITY (MIL-STD-470, MIL-STD-471, MIL-HDBK-472)
- HUMAN FACTORS (MIL-STD-1472)
- SAFETY (MIL-STD-882)
- LOGISTICS (DODD 5000.39, MIL-STD-1388)
- SURVIVABILITY (MIL-STD-2089)
- PRODUCIBILITY
- QUALITY ASSURANCE (MIL-Q-9858)
- OTHER ENGINEERING AND RELATED DISCIPLINES

ENGINEERING SPECIALTY INTEGRATION



MAJOR ENGINEERING SPECIALTY AREAS

- RELIABILITY ENGINEERING REQUIREMENTS
- MAINTAINABILITY ENGINEERING REQUIREMENTS
- HUMAN FACTORS / HUMAN ENGINEERING REQUIREMENTS
- SAFETY ENGINEERING REQUIREMENTS
- LOGISTICS ENGINEERING REQUIREMENTS

RELIABILITY IN SYSTEM/EQUIPMENT DESIGN

A. SYSTEM LEVEL REQUIREMENTS

- System Operating Requirements
- System Maintenance Concept
- Allocation Of Requirements

B. DETAIL DESIGN REQUIREMENTS

- Reliability Analysis (Block Diagrams And Math Models).
- Component Part Selection And Application
- Component Part Derating
- Redundancy In Design
- Stress - Strength Analysis
- Failure Mode And Effects Analysis (FMEA)
- Critical Useful Life Analysis
- Sneak Circuit Analysis
- Effects Of Storage, Packaging, Transportation, Handling And Maintenance
- Reliability Prediction

C. RELIABILITY DESIGN REVIEW

D. TESTING REQUIREMENTS

- Reliability Qualification Testing
- Reliability Acceptance Testing
- Life/Longevity Testing

E. QUALITY ASSURANCE PROVISIONS

F. DATA COLLECTION, ANALYSIS, AND CORRECTIVE ACTION

- Data Collection
- Failure Analysis and Corrective Action

MAINTAINABILITY IN SYSTEM/EQUIPMENT DESIGN

A. SYSTEM LEVEL REQUIREMENTS

- System Operating Requirements
- System Maintenance Concept
- Allocation Of Requirements

B. DETAIL DESIGN REQUIREMENTS

- Maintainability Analysis (Reliability-Maintainability Trade-Offs, Level Of Repair Analysis, Etc.)
- Design Characteristics - Accessibility, Diagnostic Provisions, Mounting Provisions, Standardization, Handling, Safety, Etc.
- Maintainability Prediction
- Maintenance Engineering Analysis

C. MAINTAINABILITY DESIGN REVIEW

D. MAINTAINABILITY DEMONSTRATION REQUIREMENTS

E. QUALITY ASSURANCE PROVISIONS

F. DATA COLLECTION, ANALYSIS, AND CORRECTIVE ACTION

- Data Collection
- Failure Analysis And Corrective Action

HUMAN FACTORS IN SYSTEM / EQUIPMENT DESIGN

A. SYSTEM LEVEL REQUIREMENTS

- SYSTEM OPERATING REQUIREMENTS
- SYSTEM MAINTENANCE CONCEPT
- ALLOCATION OF REQUIREMENTS

B. DETAIL DESIGN REQUIREMENTS

- HUMAN FACTORS ANALYSIS
- OPERATIONAL SEQUENCE DIAGRAMS
- DETAIL TASK ANALYSIS (OPERATOR)
- ERROR ANALYSIS
- SAFETY ANALYSIS
- DESIGN CHARACTERISTICS
  1. ANTHROPOMETRIC FACTORS
  2. HUMAN SENSORY FACTORS
  3. PHYSIOLOGICAL FACTORS
  4. PSYCHOLOGICAL FACTORS

C. PERSONNEL AND TRAINING REQUIREMENTS

- PERSONNEL QUANTITIES AND SKILL LEVELS
- TRAINING REQUIREMENTS
- TRAINING FACILITY/EQUIPMENT REQUIREMENTS

D. HUMAN FACTORS DESIGN REVIEW

E. TEST AND EVALUATION REQUIREMENTS

LOGISTICS ENGINEERING

THE APPLICATION OF SUPPORT PLANNING AND ANALYSIS TECHNIQUES TO:

- DEFINE, OPTIMIZE, AND INTEGRATE THE LOGISTIC SUPPORT CONSIDERATIONS FOR A SYSTEM INTO THE MAIN STREAM ENGINEERING EFFORT.

- DETERMINE THE OPTIMAL LOGISTICS POSTURE TO BE ESTABLISHED FOR SUPPORT OF A SYSTEM.

- PERFORM LOGISTIC SUPPORT ANALYSIS AND OTHER SYNTHESIS, MODELING, OR EVALUATION NECESSARY TO ESTABLISH OPTIMAL LOGISTIC SUPPORT REQUIREMENTS FOR THE ACQUISITION AND/OR OPERATIONAL PHASES OF A PROGRAM.

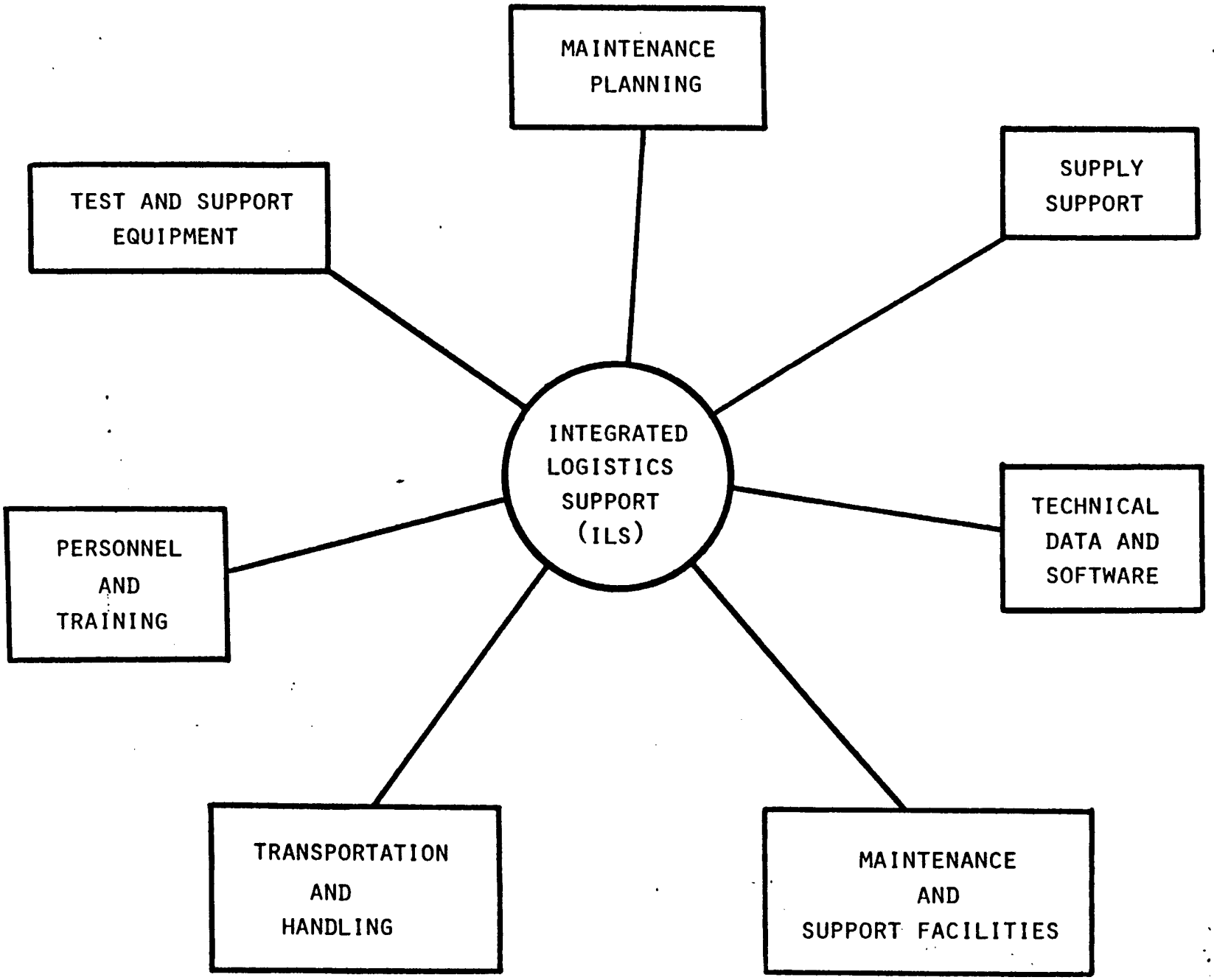
INTEGRATED LOGISTIC SUPPORT (ILS)

- DEFINITION -- A MANAGEMENT FUNCTION THAT PROVIDES THE INITIAL PLANNING, FUNDING, AND CONTROLS WHICH HELP TO ASSURE THAT THE ULTIMATE CONSUMER WILL RECEIVE A SYSTEM THAT WILL NOT ONLY MEET PERFORMANCE REQUIREMENTS, BUT ONE THAT CAN BE EFFECTIVELY AND ECONOMICALLY SUPPORTED THROUGHOUT ITS PROGRAMMED LIFE CYCLE. A MAJOR OBJECTIVE OF ILS IS TO ASSURE THE INTEGRATION OF THE VARIOUS ELEMENTS OF SUPPORT:

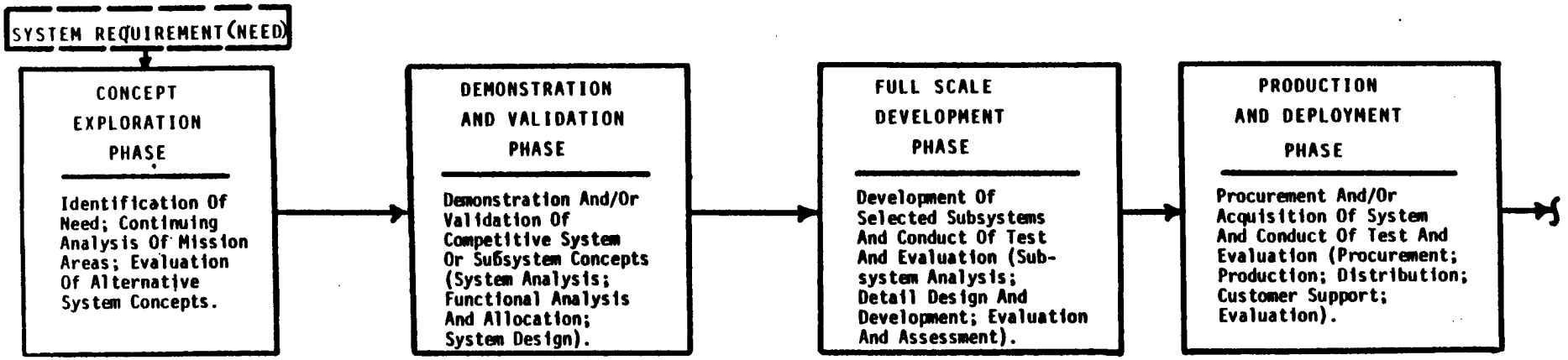
  1. MAINTENANCE PLANNING.
  2. SUPPLY SUPPORT (SPARES & REPAIR PARTS, INVENTORIES, ETC.).
  3. TEST AND SUPPORT EQUIPMENT.
  4. TRANSPORTATION AND HANDLING.
  5. PERSONNEL AND TRAINING.
  6. MAINTENANCE AND SUPPORT FACILITIES.
  7. TECHNICAL DATA AND SOFTWARE.

- APPLICATION -- LIFE CYCLE APPROACH

INTEGRATED LOGISTICS SUPPORT (ILS)



LOGISTIC SUPPORT IN THE SYSTEM LIFE CYCLE



- Integrated Logistic Support Plan (ILSP).
- Logistic Support Requirements (Input to Program Acquisition Documents).
- System Operational Requirements (Use Study).
- System Design Criteria (Standardization)
- System Analysis (Comparative Analysis, Qualitative & Quantitative Factors, System Tradeoffs).
- Logistic & Support Related Design Objectives, Goals & Thresholds, Constraints, Etc. (Maintenance Concept).

- Integrated Logistic Support Plan (ILSP) - Logistic Support Analysis Plan (LSAP).
- Functional Analysis & Allocation Of Requirements.
- Subsystems Analysis (Evaluation Of Alternative Design Configurations & Tradeoffs).
- Support Task Analysis & Logistic Support Resource Analysis (Identification Of Specific Logistic Support & Resource Requirements).
- Logistic Support Analysis Record (LSAR).
- Supportability Test & Evaluation.

- Integrated Logistic Support Plan (ILSP) - Logistic Support Analysis Plan (LSAP).
- Subsystem Analysis (Evaluation Of Alternative Design Configuration & Tradeoffs).
- Support Task Analysis & Logistic Support Resource Analysis (Identification Of Specific Logistic Support Resource Requirements).
- Logistic Support Analysis Record (LSAR).
- Provisioning Of Logistic Support Elements.
- Supportability Test & Evaluation.
- Supportability Verification.

- Support Task Analysis & Logistic Support Resource Analysis (Identification Of Specific Logistic Support Resource Requirements - Update).
- Logistic Support Analysis Record (LSAR) - Update.
- Provisioning Of Logistic Support Elements.
- Supportability Test & Evaluation.
- Supportability Verification.

L O G I S I I C S P L A N N I N G

- INITIAL LOGISTIC SUPPORT PLANNING -- DEFINITION OF SYSTEM REQUIREMENTS FOR SUPPORT, IDENTIFICATION OF PROGRAM FUNCTIONS / TASKS FOR DESIGN AND DEVELOPMENT ACTIVITIES, SCHEDULING, ORGANIZATION, FUNDING, ETC.

- FORMAL INTEGRATED LOGISTIC SUPPORT PLAN (ILSP)

1. DETAIL MAINTENANCE PLAN (DEVELOPED FROM LSA DATA)
2. RELIABILITY AND -MAINTAINABILITY PLAN.
3. TEST AND SUPPORT EQUIPMENT PLAN
4. SUPPLY SUPPORT PLAN
5. TRANSPORTATION AND HANDLING PLAN.
6. TECHNICAL DATA PLAN
7. FACILITIES PLAN.
8. PERSONNEL AND TRAINING PLAN
9. PRODUCER TO CONSUMER TRANSITION PLAN (I.E., INTERIM SUPPORT PLAN).
10. RETIREMENT PLAN.
11. MANAGEMENT PLAN

LOGISTIC SUPPORT ANALYSIS (LSA)

AN ITERATIVE ANALYTICAL PROCESS BY WHICH THE LOGISTIC SUPPORT NECESSARY FOR A NEW (OR MODIFIED) SYSTEM IS IDENTIFIED. THE LSA CONSTITUTES THE APPLICATION OF SELECTED QUANTITATIVE METHODS TO:

1. AID IN THE INITIAL DETERMINATION AND ESTABLISHMENT OF LOGISTICS CRITERIA AS AN INPUT TO SYSTEM DESIGN;

2. AID IN THE EVALUATION OF VARIOUS DESIGN ALTERNATIVES;

3. AID IN THE IDENTIFICATION AND PROVISIONING OF LOGISTIC SUPPORT ELEMENTS; AND

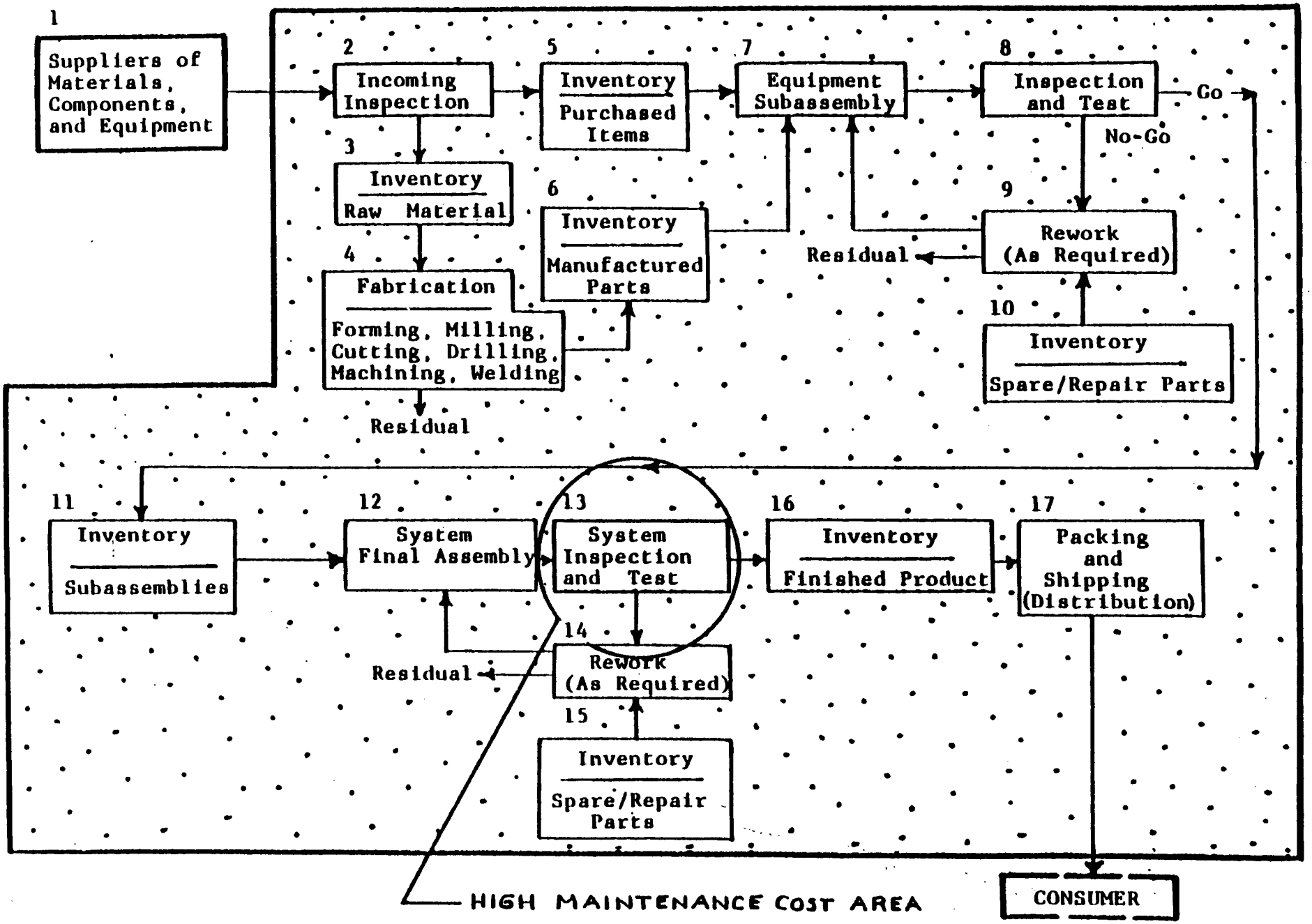
4. AID IN THE FINAL ASSESSMENT OF THE SYSTEM SUPPORT CAPABILITY DURING CONSUMER USE.

THE LSA IS A DESIGN ANALYSIS TOOL EMPLOYED THROUGHOUT THE EARLY PHASES OF SYSTEM DEVELOPMENT, AND OFTEN INCLUDES THE MAINTENANCE ANALYSIS, LIFE CYCLE COST ANALYSIS, AND LOGISTICS MODELING.

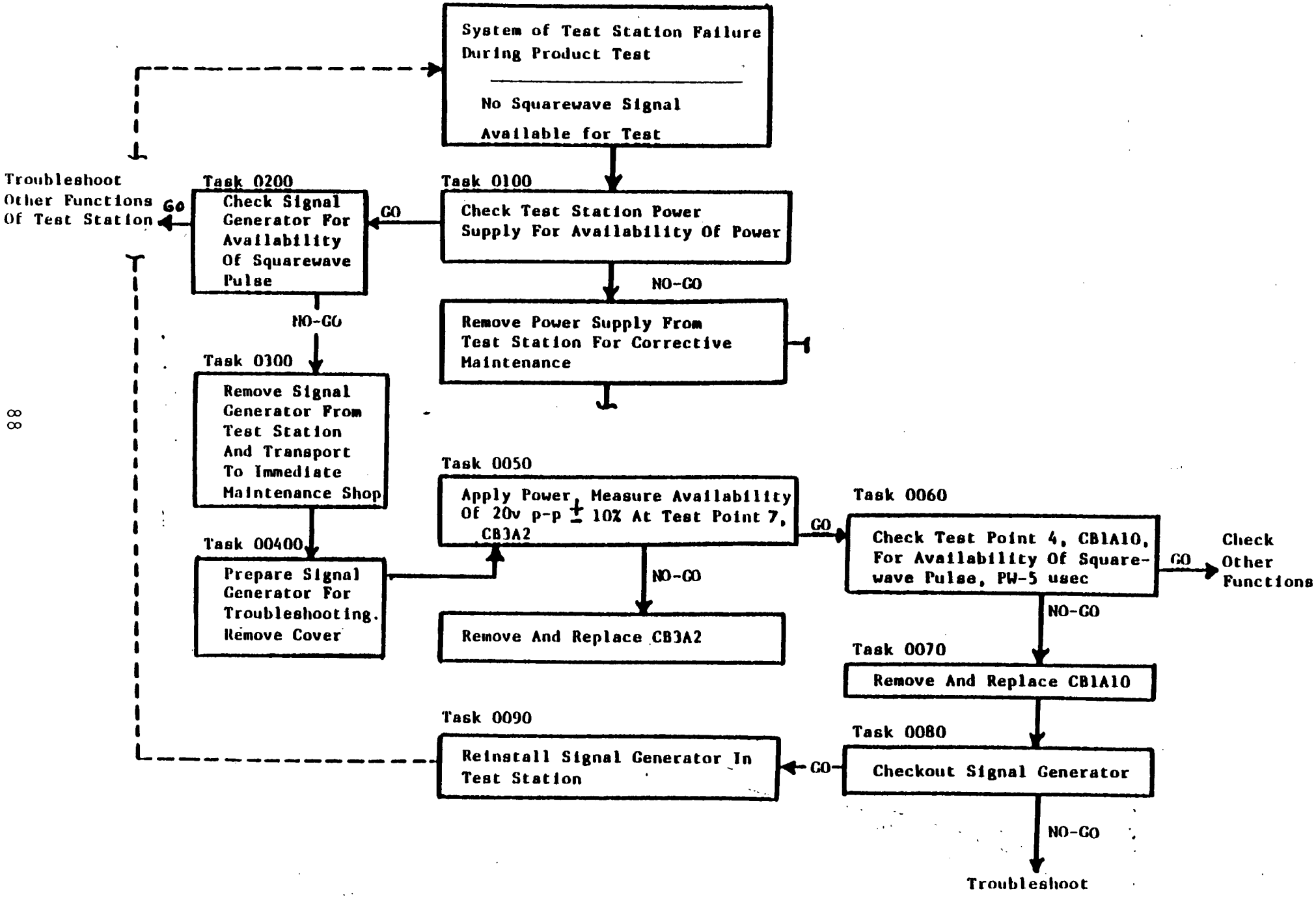
MAINTENANCE ENGINEERING

ANALYSIS

PRODUCTION OPERATION - FUNCTIONAL FLOW



ABBREVIATED LOGIC TROUBLESHOOTING FLOW DIAGRAM



MAINTENANCE TASK ANALYSIS (SHEET 1)

MAINTENANCE TASK ANALYSIS (SHEET 1)

1. SYSTEM	2. ITEM NAME/PART NO.	3. NEXT HIGHER ASSY.	4. DESCRIPTION OF REQUIREMENT:
SYSTEM TEST	TEST STATION/A12345	SYSTEM TEXT/A12300	DURING FINAL MANUFACTURING TEST OF PRODUCT "X" (SERIAL NO. 25610), THE SYSTEM TEST STATION FAILED TO PRODUCE A SQUAREWAVE SIGNAL NECESSARY FOR PERFORMANCE CHECKOUT. THE REQUIREMENT FOR TROUBLE-SHOOTING AND TEST STATION REPAIR EXISTS.

5. REQ. NO	6. REQUIREMENT	7. REQ. FREQ.	8. MAINT. LEVEL	9. MA CONT. NO.
01/02	TROUBLESHOOT & REPAIR	0.0105	ORGANIZATIONAL/ INTERMEDIATE	A20000

10. TASK NUMBER	11. TASK DESCRIPTION	12. ELAPSED TIME-MINUTES (2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38)	13. TOTAL ELAP. TIME	14. TASK FREQ.	15. PERSONNEL-MAN-MIN. B	I	S	Total
0100	CHECK TEST STATION POWER SUPPLY FOR AVAILABILITY OF POWER	①	4	0.0105	4			4
0200	CHECK SIGNAL GENERATOR FOR AVAILABILITY OF SQUARE WAVE PULSE	① ②	10	0.0105	10 10			10 10
0300	REMOVE SIGNAL GENERATOR FROM TEST STATION & TRANSPORT TO INTERMEDIATE LEVEL MAINTENANCE SHOP	①	22	0.0105	22			22
0400	PREPARE SIGNAL GENERATOR FOR TROUBLESHOOTING	③ (CYCLE 2)	6	0.0105	6			6
0500	APPLY POWER, MEASURE AVAILABILITY OF 20v P-P ± 10% @ T.P. 7, CB 3A2	③ ④	12	0.0105	12		12	12 12
0600	CHECK T. P. 4, CB 1A10, FOR AVAILABILITY OF SQUAREWAVE PULSE, PW-5μsec.	③ ④	14	0.0105	14		14	14 14
0700	REMOVE & REPLACE CB1A10	③ (CYCLE 3)	16	0.0105	16			16
0000	CHECKOUT SIGNAL GENERATOR	③ ④	8	0.0105	8		8	8 8
0900	REINSTALL SIGNAL GENERATOR IN TEST STATION	②	20	0.0105		20		20
		Σ	112	Σ	92	30	84	156

Prepared by: Blanchard Date: 9/30/77

MAINTENANCE TASK ANALYSIS (SHEET 2)

[1] ITEM NAME/PART NO.		[2] REQ. NO.	[3] REQUIREMENT	[4] REQ. FREQ.	[5] MAINT. LEVEL	[6] MA CONT. NO.
TEST STATION/A12345		01/02	TROUBLESHOOT & REPAIR	0.0105	ORGANIZATIONAL & INTERMEDIATE	A20000

[7] TASK NUMBER	[8] QTY. PER ASSY	REPLACEMENT PARTS		TEST & SUPPORT/HANDLING EQUIPMENT			[16] DESCRIPTION OF FACILITY REQUIREMENTS	[17] SPECIAL TECHNICAL DATA INSTRUCTIONS
		[9] PART NOMENCLATURE / [11] PART NUMBER	[10] REP. FREQ.	[12] QTY.	[13] ITEM NOMENCLATURE / [15] ITEM PART NUMBER	[14] USE TIME (MIN)		
0100				1	AC-DC METER SK 932101	4	ORGANIZATIONAL (ON-SITE) MAINTENANCE	CHECK POWER @ FRONT PANEL T.P. #, 115 VAC ± 10%.
0200				1	SIGNAL GENERATOR FM1291006-2	10		CHECK SQUAREWAVE PULSE @ FRONT PANEL T.P. 6, PW-5μsec.
0300				1 1	SCREWDRIVER/732102 DOLLY/24A102	22 22		TRANSPORT TO INTERMEDIATE LEVEL MAINTENANCE SHOP
0400				1 1	SCREWDRIVER/732100 SPECIAL HARNESS ASSY/GM1023	6 56	INTERMEDIATE LEVEL MAINTENANCE SHOP	BYPASS POWER DISCONNECT SWITCH S-12.
0500				1 1	POWER SUPPLY F102116-1 AC-DC METER SK 932101	12 12		MEASURE AVAILABILITY OF 20V P.P ± 10% @ T.P. 7, CB3A2.
0600				1	SIGNAL GENERATOR TM10034-10	14		CHECK AVAILABILITY OF SQUAREWAVE PULSE, PW-5μsec., T.P. 4, CB 1A10.
0700	1	CB1A10/GM10113-6	0.0105	1	SOLDERING TOOL/A1047 SCREWDRIVER/710000	16 16		CIRCUIT BOARD WILL NOT BE REPAIRED-DISCARD.
0800				1	SIGNAL GENERATOR FM1291006-2	8		REFER TO TASK 0200.
0900				1 1	SCREWDRIVER/732102 DOLLY/24A102	20 20		ACCOMPLISH OPERATIONAL CHECK OF TEST STATION. REFER TO PROCEDURE, TM-30.

TECHNICAL PROGRAM

PLANNING AND CONTROL

TECHNICAL PROGRAM PLANNING AND CONTROL

- PROGRAM REQUIREMENTS -- STATEMENT OF WORK, WORK PACKAGES, AND WORK BREAKDOWN STRUCTURE (W B S).
- TECHNICAL PERFORMANCE REQUIREMENTS AND TECHNICAL PERFORMANCE MEASUREMENT (T P M).
- SCHEDULING OF ACTIVITIES.
- ORGANIZATION FOR SYSTEMS ENGINEERING.
- DIRECTION AND CONTROL OF PROGRAM ACTIVITIES.
- SUPPLIER / SUBCONTRACTOR ACTIVITIES.
- PROGRAM REVIEW AND EVALUATION.

WORK BREAKDOWN STRUCTURE (WBS)

DEFINITIONS:

- WORK BREAKDOWN STRUCTURE (WBS) -- A PRODUCT-ORIENTED FAMILY TREE COMPOSED OF HARDWARE, SERVICES, AND DATA WHICH RESULT FROM PROJECT ENGINEERING EFFORTS DURING THE DEVELOPMENT AND PRODUCTION OF A DEFENSE MATERIEL ITEM, AND WHICH COMPLETELY DEFINES THE PROJECT / PROGRAM.

- SUMMARY WORK BREAKDOWN STRUCTURE (SUMMARY WBS) -- CONSISTS OF THE TOP THREE LEVELS OF A WBS.

- CONTRACT WORK BREAKDOWN STRUCTURE (CONTRACT WBS) -- DEFINED AS THE COMPLETE WBS FOR A CONTRACT, DEVELOPED AND USED BY A CONTRACTOR IN ACCORDANCE WITH THE CONTRACT WORK STATEMENT.

REFERENCE: MIL-STD-881A, MILITARY STANDARD, WORK BREAKDOWN STRUCTURE FOR DEFENSE MATERIEL ITEMS, APRIL 1972.

WORK BREAKDOWN STRUCTURE (WBS) -- AIRCRAFT SYSTEM

LEVEL I	LEVEL 2	LEVEL 3
AIRCRAFT SYSTEM	AIR VEHICLE	AIRFRAME; PROPULSION UNIT, COMMUNICATIONS; NAVIGATION AND GUIDANCE; FIRE CONTROL; PENETRATION AIDS, RECONNAISSANCE EQUIPMENT; FLIGHT CONTROL; CENTRAL INTEGRATED CHECKOUT; ANTISUBMARINE WARFARE; AUXILIARY ELECTRONICS; ARMAMENT; WEAPONS DELIVERY.
	TRAINING	EQUIPMENT; SERVICES; FACILITIES
	PECULIAR SUPPORT EQUIPMENT	ORGANIZATIONAL; INTERMEDIATE; DEPOT
	SYSTEM TEST AND EVALUATION	DEVELOPMENT TEST AND EVALUATION; OPERATIONAL TEST AND EVALUATION; MOCKUPS; TEST AND EVALUATION SUPPORT; TEST FACILITIES.
	SYSTEM/PROJECT	SYSTEM ENGINEERING; PROJECT MANAGEMENT
	DATA	TECHNICAL PUBLICATIONS; ENGINEERING DATA; MANAGEMENT DATA; SUPPORT DATA; DATA DEPOSITORY.
	OPERATIONAL/ SITE ACTIVATION	CONTRACTOR TECHNICAL SUPPORT; SITE CONSTRUCTION; SITE/SHIP/VEHICLE CONVERSION.
	COMMON SUPPORT EQUIPMENT	ORGANIZATIONAL; INTERMEDIATE; DEPOT
	INDUSTRIAL FACILITIES	CONSTRUCTION/CONVERSION/EXPANSION; EQUIPMENT ACQUISITION OR MODERNIZATION; MAINTENANCE
	INITIAL SPARES AND INITIAL REPAIR PARTS	SYSTEM/SUBSYSTEM/COMPONENT SPARES AND REPAIR PARTS.

REFERENCE: MIL-STD-881A, MILITARY STANDARD, WORK BREAKDOWN STRUCTURES FOR DEFENSE MATERIEL ITEMS, APRIL 1975.

WORK BREAKDOWN STRUCTURE (WBS)

PROVIDES:

- PRIMARY FRAMEWORK FOR DEFINING, ALLOCATING, AND SCHEDULING WORK AND BUDGET.
- MEANS FOR MEASURING AND EVALUATING PROGRESS AGAINST PLANNED MILESTONES.
- BASIS FOR NEGOTIATING CONTRACT PACKAGES.
- ASSIGNMENT OF MANAGEMENT RESPONSIBILITY.

TECHNICAL PERFORMANCE MEASUREMENT (TPM)

THE CONTINUING PREDICTION AND DEMONSTRATION OF THE DEGREE OF ANTICIPATED OR ACTUAL ACHIEVEMENT OF SELECTED TECHNICAL OBJECTIVES. IT INCLUDES AN ANALYSIS OF ANY DIFFERENCES AMONG THE "ACHIEVEMENT TO DATE", "CURRENT ESTIMATE", AND THE SPECIFICATION REQUIREMENT. "ACHIEVEMENT TO DATE" IS THE VALUE OF A TECHNICAL PARAMETER ESTIMATED OR MEASURED IN A PARTICULAR TEST OR ANALYSIS. "CURRENT ESTIMATE" IS THE VALUE OF A TECHNICAL PARAMETER PREDICTED TO BE ACHIEVED AT THE END OF THE CONTRACT WITHIN EXISTING RESOURCES.

SELECTION OF PARAMETERS (KEY POINTS)

The identification of all technical performance parameters is a product of the System Engineering process, where the technical performance requirements are contained within System Element Specifications and/or Contract Item Specifications. The selection of parameters to be tracked and reported is a function of the TPM effort. Parameters are normally selected for one of the following reasons:

Contractually Required

Mission Critical

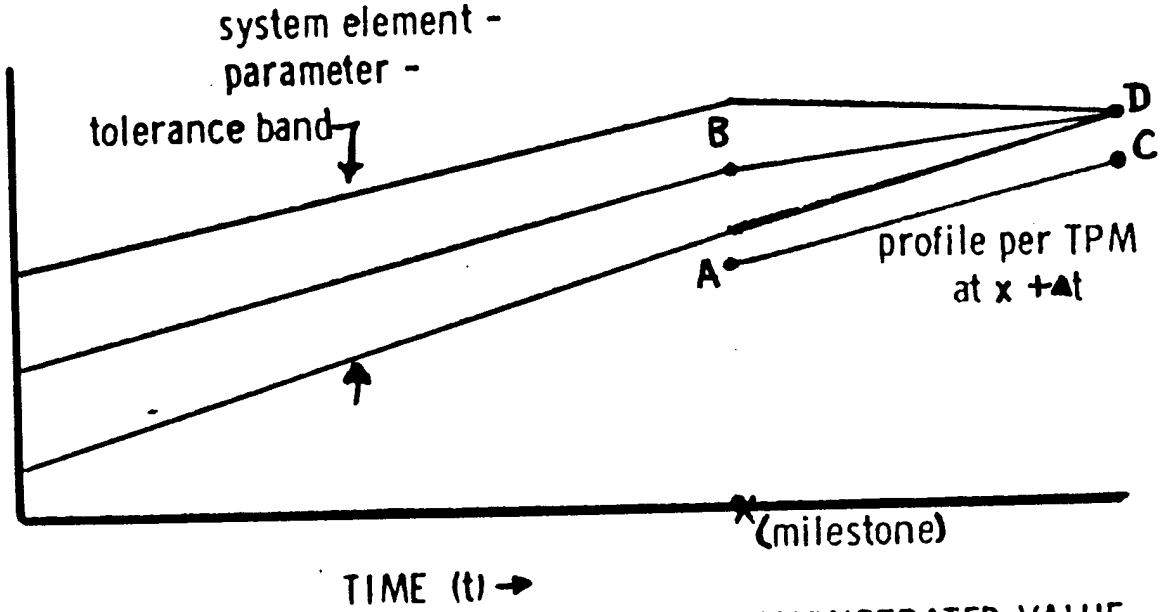
State-of-art Critical

Incentive Related

Selection of these parameters is a responsibility assigned to the contractor; approval of the selection is a function retained by the customer. It seems apparent that a negotiated position must be reached on the selected listing, since there is a tendency for the contractor to desire a lesser number of reporting parameters, where the customer tends to go to a greater number.

Using the Program Work Breakdown Structure numbering system, each parameter tracked or reported is identified to elements of the WBS. A potential problem exists here in that there is a pyramid effect in successively lower levels of parameter structure breakout. Where reported parameters may be increased twofold, tracked parameters may increase 6 or 8 times. There should be a strong emphasis on obtaining a sound rationale used to select the optimum number of reported parameters on a particular program since the cost of doing TPM is closely associated with the number of parameters tracked and reported.

TPM ILLUSTRATION



A : DEMONSTRATED VALUE
B. PLANNED VALUE
C: CURRENT ESTIMATE
B – A : DEMONSTRATED VARIANCE
D : SPECIFICATION REQUIREMENT
D – C: PREDICTED VARIANCE

CONFIGURATION MANAGEMENT

THE ENGINEERING MANAGEMENT PROCEUDURE THAT INCLUDES:

- CONFIGURATION IDENTIFICATION -- SELECTION OF DOCUMENTS WHICH IDENTIFY AND DEFINE THE CONFIGURATION BASELINE CHARACTERISTICS OF AN ITEM (PROVIDES THE SPECIFIC TECHNICAL DESCRIPTION OF AN ITEM AT ANY POINT IN TIME).

- CONFIGURATION CONTROL -- CONTROLLING CHANGES TO THE CONFIGURATION AND ITS IDENTIFICATION DOCUMENTS.

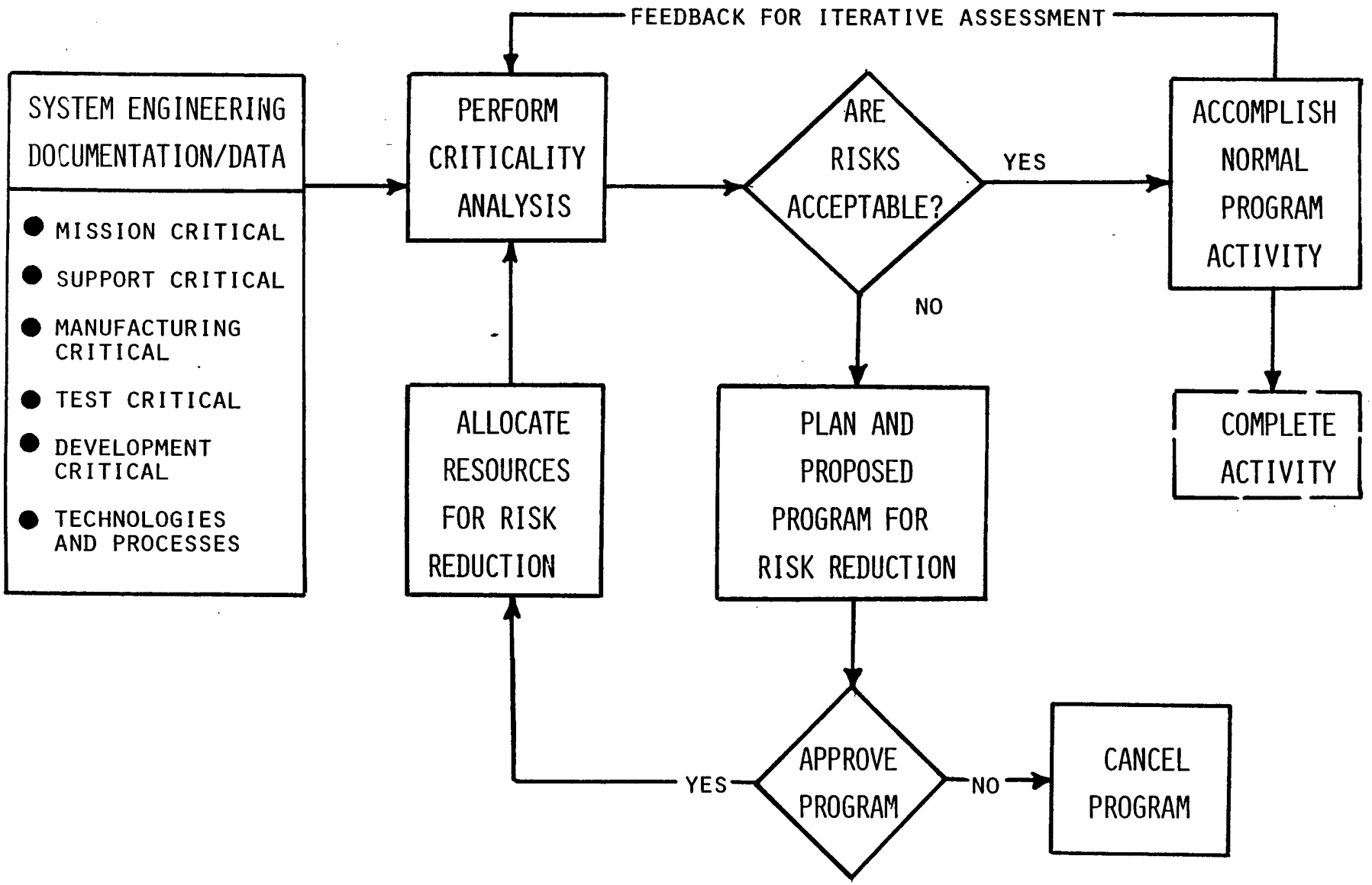
- CONFIGURATION STATUS ACCOUNTING -- RECORDING AND REPORTING THE IMPLEMENTATION OF CHANGES TO THE CONFIGURATION AND ITS IDENTIFICATION DOCUMENTATION.

- CONFIGURATION AUDIT -- CHECKING AN ITEM FOR COMPLIANCE WITH THE CONFIGURATION IDENTIFICATION.

CONFIGURATION MANAGEMENT IS A MANAGEMENT DISCIPLINE, APPLIES CONTROLS, AND IS A COMPLEMENTARY FUNCTION TO SYSTEMS ENGINEERING.

RISK AND RISK MANAGEMENT

(PROBABILITY OF NOT MEETING A SYSTEM REQUIREMENT)

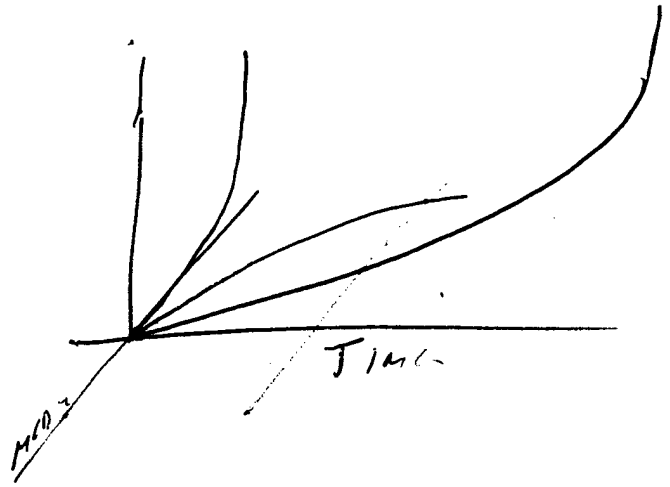


S Y S T E M E N G I N E E R I N G

A DISCIPLINE THAT LEADS TO:

- DEFINITION OF A COMPLETE SYSTEM.
- DEFINITION OF A SYSTEM IN TERMS OF ITS OVERALL LIFE CYCLE (I.E., A LIFE-CYCLE VIEWPOINT).
- PROVIDING ASSURANCE THAT THE VARIOUS ELEMENTS OF THE SYSTEM ARE PROPERLY INTEGRATED.
- ASSURING CORRELATION, CONSISTENCY, AND TRACEABILITY.

THE OBJECTIVE IS DISCIPLINE-ORIENTED OR PROCESS-ORIENTED--NOT TO IMPOSE ADDITIONAL REQUIREMENTS OR MORE WORK.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